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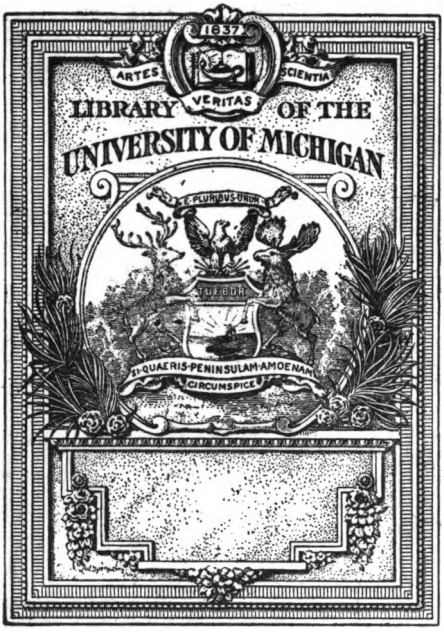

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OF

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ASSOCIATIONS

OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

REPORTS OF PROCEEDINGS

DURING

1888

OF THE

Eastern Counties Gas Managers' Association,
Manchester District Institution of Gas Engineers,
Midland Association of Gas Managers,
North British Association of Gas Managers,
North of England Gas Managers' Association,
North of Ireland Association of Gas Managers,
Scottish Gas Managers at Glasgow,
Southern District Association of Gas Engineers and Managers,
AND
South-West of England District Association of Gas Managers.

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REPORTS OF PROCEEDINGS.

ASSOCIATIONS OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

1888.

SOUTHERN ASSOCIATION.

ANNUAL MEETING, FEB. 9.

This Meeting was held at the Guildhall Tavern, London—Mr. J. L. CHAPMAN, Assoc. M. Inst. C.E. (the President), in the chair.

The minutes of the previous meeting having been taken as read,

The following gentlemen were elected members of the Association:—Mr. H. Hamilton, Gas-Works, Chertsey; Mr. Raphael Herring, Gas-Works, Dover; Mr. Norton H. Humphrys, Gas-Works, Salisbury; and Mr. F. Mead, Gas-Works, Sutton.

The HONORARY SECRETARY (Mr. J. W. Helps, of Croydon) then read the annual report of the Committee, as follows:—

In presenting the thirteenth annual report, the Committee beg to congratulate the members upon the continued prosperity of the Association, which now numbers 78 members, five of whom were elected during the year just closed.

Three meetings were held in the course of the past year, under the presidency of Mr. W. D. Child, of Romford, to whom the warmest thanks of the Association are due for his able presidency.

The first meeting was held on the 10th of February, at the Guildhall Tavern, at which the President read his interesting address.

The second meeting took place on the 2nd of May, when the Association visited both Reading and Maidenhead. At Reading they were most kindly received, entertained, and shown over the works of the Reading Gas Company, by the Chairman, Directors, and Engineer of the Company (Mr. E. Baker, Assoc. M. Inst. C.E.), who explained the difficulties he had had to encounter in constructing the new works, and the various methods employed to overcome them. The Committee beg to recognize, in the most grateful manner, the courtesy and genial kindness displayed to the members of the Association by the Chairman, Directors, and Staff of the Reading Gas Company. The members of the Association were also much

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gratified by their visit to the Maidenhead Gas-Works, and were especially pleased with the novel manner in which the Engineer had overcome the difficult task of erecting so large a plant on so small a space.

The third meeting was held at the Guildhall Tavern on the 10th of November, on which occasion a very useful paper was read by Mr. J. Somerville, giving a description of a regenerative tar-furnace. This paper was very fully and instructively discussed. Mr. C. W. Folkard also read a very valuable and thoughtful paper on "Carbonization," which, opening up as it did new lines for thought, should be productive of benefit to the members, by leading to investigations which may possibly serve as bases for future communications to the Association.

The Committee are of opinion that the funds of the Association are in such a healthy state that they will be justified in again presenting each member with a copy of the printed report of the proceedings of the various District Associations for the year 1887.

The Committee feel that much of the prosperity of the Association is due to the energy and ability displayed by the former Honorary Secretary, Mr. J. L. Chapman, who so ably conducted the affairs of the Association from the date of its formation, on July 15, 1875, to the date of his election to the presidential chair in November last; and from their knowledge of the energy and ability of the present Honorary Secretary, Mr. J. W. Helps, of Croydon, the Committee feel assured the Association will find in him an excellent successor to Mr. Chapman, and one who will continue its career of usefulness, instruction, and sociability to its existing and future members.

The balance-sheet shows the receipts for the year to be £32 0s. 6d.; and the expenditure during the same period to be £34 7s. 4d. This with the sum of £43 4s. brought forward from 1886, leaves a balance in hand of £40 17s. 2d.

The PRESIDENT moved—"That the Committee's report be received and adopted and entered on the minutes."

Mr. C. GANDON (Sydenham) seconded the motion, which was unanimously carried.

The PRESIDENT then read the following

INAUGURAL ADDRESS.

Gentlemen,—It is now thirteen years since the Southern District Association of Gas Engineers and Managers was started. During the whole of this time I have had the privilege of serving you as Secretary; and pleasant are the memories which to-day come to me as I recall the friendships that I have formed through my connection with the Association.

I thank you for the position that you have placed me in to-day, and for the encouragement, ready and, I may say, substantial sympathy you have extended to me in the days that have gone by. I have a clock in my dining-room which never allows me to forget the great kindness of the members of this Association. The Committee some short time ago asked me to take upon myself the responsibility of President; but I was afraid the Association's prestige

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might suffer at my hands, so I desired to remain in the place where brilliant talents were not so much needed, but where a little thoughtful industry might conduce to your benefit. I have now, however, emerged from the den of the Secretariat into the daylight of the Presidentship; and trust by my earnest endeavours, and by the continuance of your kind generosity, to hand down the position undimmed to my successor.

It is the habit of some societies to see everything that is beautiful in themselves, and everything that is the opposite in kindred associations. To me it is a genuine joy to recognize the harmonizing influence that all the District Associations have had upon their members, bringing them together, and so breaking down the barriers that had separated them in the days of yore. The unique position which the gas engineer fills, isolates him from his fellows. As a rule, there is but himself of his profession in the town in which he resides; and, being connected with a concern which is somewhat of a monopoly, he is looked upon suspiciously by the public. I do not know, nor can I explain why, complaints made to the manager of a gas-works should so often contain about as much acidity as it is possible to put within the four sides of a sheet of note-paper.

Our Association has for some time been somewhat stagnant in the increase of its members. But at the last meeting, there were five new members enrolled, and I am pleased to see that four more have been elected to-day; so that our total membership is now 82. I do not think, however, that the usefulness of our society depends upon the number of its members (for it may easily become unwieldy), but upon that personal interest which has been taken in it from its earliest days by those conducting its affairs, and especially by the sustained sympathy of the Past-Presidents. I should like to leave upon record at this time how much of our success has been due to the counsels of one who is no longer with us. I refer to Mr. James Eldridge, who made his office at Richmond the place for the transaction of our business, and his house the place for the reception of his hospitality.

It has been wisely determined by the Association that only three meetings should be held in the year, instead of four as at the first. At the August meeting there was always a poor attendance; and it was unfair to ask any member to read a paper before such small gatherings. In the past year we had three well-attended meetings. At the first one, in February, we had a most interesting address from our President; and at the second, I think there were 50 members present. I refer to the morning, in May last year, that we spent under the guidance of Mr. E. Baker and his Directors at the Reading New Gas-Works. The massive

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structure, the beautiful workmanship, and the many new departures from traditional architecture and engineering impressed us; and whatever our different ideas were as to whether we should or should not have carried out work in such a complete form, we all came away acknowledging that the works throughout had been conceived and constructed in a truly scientific spirit, and that they would be an ornament to that historic town, and, according to my views, a complete benefit to the Company which has entrusted its destinies to the care of our member and their Engineer, Mr. Baker. We had the opportunity of seeing the designs of those works from foundation to chimney; and throughout the careful attention to detail was as perfect as the *tout ensemble* was complete. Our President must have been delighted with the technical knowledge displayed; for in no place is it of more consequence than in first construction. The adaptation of theory to the practical carrying out of works is one of the important branches that will be greatly benefited by improved technical education. The hospitality we received at Reading was of the generous order, and had something in common with the work we went to view. The visit to the Maidenhead Gas-Works, afterwards, was also very instructive; inasmuch as the members had an opportunity of witnessing the very ingenious manner in which the Engineer had utilized the space at his disposal, and had succeeded in putting up a comparatively large plant on a very limited area.

In these days when every question is so quickly ventilated either at Association meetings or in the columns of the professional journals, it often causes considerable anxiety to the Committee to obtain a paper that shall be worthy of your consideration. At our third meeting held in November last, we had read to us two papers, which were both instructive and interesting. I feel that we must do all we can to encourage members to lay their views before us upon any subject on which they have bestowed special attention; and no greater encouragement can they have than when they receive the hearty acknowledgments of this Association. Mr. Somerville, although somewhat driven in his time for preparation, laid before us a well-considered paper upon a "burning" subject—the use of tar for heating retorts. The right moment was chosen by him for the purpose—a rising coke market in the Metropolis, with a stagnant, if not falling tar trade. The communication contained thoughtful theory put into careful practice, with no imaginary or uncertain benefits, but certain and weighed results, giving the quantity of tar consumed and the increase in money-value as compared with coke burned under the same conditions. We were indebted to Mr. Folkard, in conjunction with Mr. Heisch, jun., for an interesting paper upon

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carbonization. This was a lucid exposition of experimental work undertaken by these gentlemen. Some of their hypotheses were new and somewhat startling; but much time and trouble had been bestowed upon their experiments. I think the dearth of discussion (as was remarked by Mr. Goddard at the time) was due to no want of appreciation on the part of the members, but by the newness of the propositions, and the impossibility of debating a subject which required some consideration before it could be grasped.

I have prepared some figures showing the increase in the gas undertakings with which the members of this Association are connected, which has taken place in the five years from 1881 to 1886. I have divided them into three classes—(1) The London and large Suburban Companies; (2) the smaller Suburban Companies; and (3) the Country Companies. According to the parliamentary reports from which I have obtained the information, I find that in 1881 the total subscribed capital of all these Companies was, including borrowed moneys, £5,512,000; and in 1886 it had reached £6,600,000—being an increase in the six years of £1,088,000. The London and larger Suburban Companies have increased in this respect during that time by £728,000, or 21 per cent. on their subscribed capital; the ordinary Suburban Companies, by £79,000, or 11 per cent.; and the Country Companies by £281,000, being 20 per cent. In 1881, the total quantity of coals consumed by these Companies was 892,000 tons; and in 1886, 1,153,000 tons—an increase of 261,000 tons. The London and larger Suburban Companies increased their consumption in this period by 197,000 tons, or 33 per cent., the smaller Suburban Companies, by 19,000 tons, or 27 per cent.; and the Country Companies by 44,000 tons, or 20 per cent. The quantity of gas sold in 1881 by these Companies, independent of that used on the works, was 8172 million cubic feet; and in 1886, 10,978 million cubic feet—an increase of 2806 millions. The consumption in the case of the London and larger Suburban Companies advanced by 2109 million cubic feet, or 38 per cent.; the smaller Suburban Companies, by 216 million feet, or 32 per cent.; and the Country Companies, by 481 million feet, or 24 per cent. In 1881 the total leakage and quantity of gas used on the works of these Companies was 731 million cubic feet, or 8·22 per cent. of the gas produced; and in 1886, this had only increased to 817 million cubic feet, and had reduced in percentage to 6·93. During these five years the reduction in the price of gas by the London and large Suburban Companies has been 7d. per 1000 cubic feet; and by both the smaller Suburban Companies, and the Country Companies, 4d. per 1000 cubic feet.

The unique position of London as the mart of the world is shown in the peculiar increase in the gas undertakings there—an average

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of one-third more than that of the Country Companies. Suburban London is treading closely upon its heels.

In country places leakage is a serious item; and the distributing plant must there be maintained in a high state of efficiency. Within the parliamentary limits of the gas undertaking at Harrow, there are sparsely populated districts through which the gas-pipes run for long distances; in fact in one portion there are nine miles of mains to 70 consumers. It may be instructive if I refer to the improvement that was made by carefully overlooking our mains and service-pipes. In 1878—the unaccounted-for gas stood at 2,122,000 cubic feet, or 9·47 per cent. of the gas produced. From this time steam-tube has been used for new service-pipes and for the replacement of old ones. My impression is that the use of this instead of the ordinary gas-tube is imperative. The expense of putting gas-tube into troughs and running with pitch cannot be borne by the smaller suburban or country undertakings; whereas the steam-tube increases the original cost but slightly. By this means, and by attention to trivial escapes, by the year 1881, there was a reduction in the leakage of 660,000 cubic feet; and the unaccounted-for gas only represented 6·24 per cent. of the gas produced. This satisfactory progress was, however, soon impeded; for the Local Authorities just then proceeded with a system of main drainage through three miles of the country roads where our pipes were laid. The effect of this was to raise again the unaccounted-for gas to beyond 9 per cent. The former success, however, nerved me to again persevere with systematic testing of short lengths of pipe where the roads had been disturbed. Although the expense was large (part of which was paid by the sewer contractor), it was money wisely spent; for in 1886 the unaccounted-for gas was reduced to 1,413,000 cubic feet—being 4·66 per cent. of the gas produced. In dealing with this matter, it is impossible to rest on your oars. We are again troubled with an increasing leakage, due to the exceedingly dry summer of the past year. The foundations of several houses that have been built for over 20 years have moved, so as to require underpinning. Six or seven gas-pipes were broken clean in half; and a considerable number of small leaks have been caused by the drawing of the joints. Although these were attended to as soon as discovered, the unaccounted-for gas in the past half year was 2 per cent. more than in the corresponding period of the preceding year. Nothing can more clearly demonstrate, than the foregoing, the necessity for careful examination of all mains and services. My experience tends to prove that the greater proportion of the leakage is to be found where the pipes are in the open country roads, rather than in roads where they are bounded by houses.

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Dividends are said to be made in the retort-house; but they will be found a slippery store, unless careful provision be made to prevent them running away when they have passed from that domain.

Within the last ten years considerable strides have been made in the improvement of the methods of consuming gas for illumination. We have just heard of a further advance in the new regenerative lamp invented by Mr. F. Siemens. Nothing, I venture to think, will contribute so much to extend the use of gas as this competition in the design and manufacture of properly-constructed burners. The lighting of the streets and of most of the railway stations was, not many years since, as mediæval darkness when compared with the lighting of to-day. For comfort and brightness in an ordinary room, I consider the improved flat-flame burner, with open globe, to be the acme of perfection. With any lamp that does not allow the light to be thrown upon the ceiling, and thence reflected through the room, there is a peculiar dreariness, which is to me exceedingly unpleasant.

The two systems of lighting, however, which are now receiving the special attention of inventors are the regenerative and the incandescent. The regenerative, of which there are a number of different makers, seems to be most adapted to the lighting of business premises and public places of resort. This method is certainly "taking" with the public, if one may judge from the number of the lamps that there are in use. One form in which it is almost perfect is in the reading-lamp, the light from which is strong, and some of the designs are very effective. The incandescent light came prominently before the world by an extraordinary prospectus, in which promises were made of alarming dividends, to be earned in an easy manner by investing £300,000, which did not seem altogether satisfactory. The Welsbach lamp has now been in public use for some time, but it does not seem to have reached any great popularity. In the autumn of last year, I was in Vienna, which, I believe, was the birthplace of this light; but I observed but few of them in use there. The reason of the only partial success of the lamp is its fragility. A consumer of mine bought two to put in his shop. Hearing of his purchase, I called in one evening in order that I might have the pleasure of seeing them in operation; but, before I arrived, they had collapsed. Being a determined man, he went himself and bought some more of the cones; but although carefully packed, and carried in the hand, he arrived home with them completely shattered. This is the only trial I have known of in the Harrow district, although the place for their sale is within ten miles. I was present when some experiments were made with the Clamond burner a short time since; and this light was exceedingly brilliant. I have not been able to

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examine it carefully; but, from its appearance and the report of its durability, for some particular places it may become a success. There cannot be a doubt that unless these burners can be strongly constructed, so as to be capable of carriage, they will in the end prove such a nuisance that they will have no claim upon the ordinary consumer.

Ventilation bears very closely upon the combustion of gas in the living rooms of a house. This necessity has often been referred to as a drawback to the use of gas. Perhaps the objection may be right; but unventilated rooms must be unhealthy under any circumstances. I have found that if, as soon as the gas is lighted, a window be left slightly open at the top, adjusting it according to the condition of the atmosphere, the room may be maintained in a pleasant and comfortable state, without any of the oppressiveness of which complaint is so often made. If proper care is taken, it is but reasonable to suppose that gas should rather tend towards improved ventilation by causing a circulation of the air. It would be well if this prejudice with regard to the vitiation of air by the use of gas, which has certainly some hold upon the public mind, could be removed by experiments on this subject, showing where the excess of carbonic acid gas really is, whether it is not, in fact, to be found more in the places not lighted by gas rather than in those that are, and also whether it is not in much closer contact with the person where the gas-light is absent.

It is somewhat peculiar that where low prices for gas are charged, there is often more dissatisfaction between the local authority and the gas company than where higher prices are maintained. I certainly think that great care should be exercised to preserve a good understanding between gas companies and local authorities. Often some rather sharp letter or ill-advised clinging to an original price, which might be abated, or anyway discussed, creates a disagreeableness which is never overcome. "The beginning of strife is as when one letteth out water; therefore leave off contention before it be meddled with," is the advice of the wisest man. Nothing will mar the prosperity of a gas company, or destroy the comfort of the engineer, more than a settled antagonism between these two powers. I take it to be the duty of every gas official to treat the local authority with due consideration, and to remember the benefits conferred upon the companies by their several Acts of Parliament, to some extent at the expense of these bodies. That portion of the Gas-Works Clauses Amendment Act of 1871 is quite on the lines of righteous law which compels the gas to be supplied to the public lamps at the lowest price in the district. I consider it is often to the gas company's interest to go beyond this, and charge even a lower price than that

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demanded by the Act. In new roads where there are only few consumers, the public lamps are an advertisement. They show that the gas is there ready for whoever may desire it. The local authority is usually a large consumer; although the gas is supplied at different points, the account is delivered in one amount, and causes no trouble in collection. Bad debts are an impossibility; and therefore they can be left out of the calculation.

A clause in the Act of 1871 to which I have just referred, enables a gas company to claim a deposit from every consumer according to the value of the gas he is likely to use—a reasonable safeguard; but one which requires considerate handling. In the case of some companies almost every consumer, whatever his position or station in life may be, is compelled to place an amount of money in the company's hands. This action I think to be unwise, and contrary to sound business principles, although, there is no doubt that many companies do prosper in spite of themselves. In my opinion, could the stringency of this claim be modified, although perhaps the bad debts would be slightly augmented, still the consumption of gas would increase in a much greater ratio. I look upon this clause as only a protective one, to be used when necessity compels—when either the person is known to be unstable or no satisfactory references are forthcoming. I can quite understand the annoyance that is so often felt at this demand, and at the determination of doing without gas rather than submit to it; while to many small tradesmen beginning life, £2 or £3 taken out of their capital compels them to use other illuminants.

The interesting article which appeared a short time since in the *Journal of Gas Lighting** by Mr. S. Penny, upon the admission of air to the purifiers, deserves notice, although when it was published different correspondents desired to deny its originality and to consign it to ancient history. My experiments in this direction have been satisfactory. The air at the Harrow Gas-Works is admitted in the hydraulic main at the furthest point from the exhauster, and then carried with the hot tar and gases as long as possible. In the summer season the purifiers remained unfouled for some months, and with but little deterioration in the illuminating power. The quantity of air admitted was very irregular, although the heat of the retorts was high and regular. Sometimes 5 per cent. would not affect the luminosity, and at other times ½ per cent. was too much, according to the conditions of the purifying material. During the winter months the air admitted had to be greatly reduced, and often stopped altogether, on account of the reduction in the illuminating power. I do not know whether

* See Vol. L., p. 750.

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the cause of this was the oxide being fully charged with sulphur, or the passage of the gas being very rapid through small purifiers. A difficulty that first troubled me was the great increase in pressure; but this was overcome by placing the oxide in several tiers, and keeping the layers rather thin. Although only two-thirds of the material which had been used in the ordinary way was put into the boxes, they ran without the necessity of change as long as when they were filled with the larger quantity. During the hot weather, while this system was in use, there were very serious deposits of naphthalene in the inlet of the gasholder; and slight signs of it were also observed in the purifiers. After the pressure-gauges once showed a slight increase of pressure, it was but a day or so before the pipe was so blocked that it was necessary to steam it before a proper passage could be secured. One objection to taking in the air at the hydraulic is the increase in the amount of fixed ammonia in the liquor. At Harrow we make the liquor into sulphate; and by using rather more lime, there has been no decrease in the quantity of the salt produced.

Two systems are before the gas profession at the present time to facilitate still further the revival of oxide *in situ*—one is the process of Mr. Hawkins for carburetting the air; and the other the manufacture of oxygen gas to be used in place of the air. Complete experiments, I understand, are now proceeding at the Westgate works with this gas; and I doubt not that before many months have passed we shall know from Mr. Valon, the value of this invention—whether or not there will be any gain by its adoption.* If the whole purification of the gas from sulphuretted hydrogen can be made without any removal of the oxide until it is completely saturated with sulphur, it will be a great advance. There is not only the expense of removal and replacing on the change of purifiers that will be saved, but the larger one of opening up and turning the oxide for proper revivification. The space occupied for this is considerable; and the appearance and smell could comfortably be dispensed with.

Experiments in the direction of the use of Weldon mud for purposes of purification have been lately occupying attention.† About its real value, there is considerable difference of opinion. If, as is claimed for it, it reduces the sulphur compounds to an extraordinary degree, it will be a Koh-i-noor to all those engineers who

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* Mr. Valon's report on the experiments here referred to appeared in the *Journal of Gas Lighting* for Feb. 21, 1888, p. 330.

† See paper by Dr. J. J. Hood and Mr. A. Gordon Salamon, read before the London Section of the Society of Chemical Industry, Jan. 2, 1888 (*Journal of Gas Lighting*, Vol. LI., p. 64).

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are tied and bound by the sulphur clauses in their Acts of Parliament; and beyond this will be beneficial to those smaller companies who, though not under these clauses, could, if it was unnecessary to enlarge their plant, remove these impurities at a minimum of expense. I question whether any material can be cheaper than bog ore, or more convenient in its application for the removal of sulphuretted hydrogen. The composition of Weldon mud is as follows:—

Oxide of manganese (MnO_2)	24·78
Chloride of calcium ($CaCl_2$)	25·04
Oxide of calcium (CaO)	4·68
Carbonate of calcium ($CaCO_3$)	2·50
Silica (SiO_2)	2·20
Chlorides of magnesia, soda, and potash	14·36
Moisture at 212° Fahr.	19·34
Water lost on ignition	6·76
Oxide of iron	trace
	99·66

Theory and practice as to what temperature it is best that gas should leave the condenser, are still matters upon which there is a great divergence of opinion. If higher temperatures are more satisfactory than, or as satisfactory as lower ones, so much less capital will be needed upon this portion of the plant; and by so much the expenditure will be relieved. I am inclined to take sides with the advocates of the higher temperatures, where the scrubbing and washing apparatus are complete. If it can be proved that the higher temperature is as good as, even if it is not better than the lower, it should be adopted, as it is never scientific to spend money or power on that which is unnecessary. In conversation with one of our members, I was very surprised to find that he was using in his finishing washers, water at a temperature of from 70° to 90° Fahr., and was by this means removing considerably more of both carbonic acid and sulphuretted hydrogen in this apparatus than he did when the water was at the ordinary temperature, and that water at 90° Fahr. was the most effective. The reduction of the ammonia in the liquor seems almost a natural corollary; but he assured me that he had tested it, and there was no decrease.

The Sunday labour question has lately been a subject of discussion at the meetings of the Gas Committee of one of the large Corporations. I cannot understand how the point at issue can be lost sight of. The one day of rest in seven is a divine appointment; and for me that is a sufficient reason why, as far as possible, carbonizing should cease in my works. It also affects the social system of this country. Manufactories with but few exceptions are

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closed upon the Sunday. In small gas companies, pressed with heavy capital, it may not be possible to have sufficient storeage room for the cessation of work during the three darkest months; yet if by any means they can then keep the supply without failure, surely it must be possible to discontinue work for twelve hours out of every 168 during the other nine months of the year. With large works it only needs the will to make the way. Every manufacturer has to lay out his capital so as to do the work he needs in the six days of the week; and gas companies, and especially corporations, should everywhere be called upon to do the same. I completely disagree with giving a higher rate of wages for Sunday labour, because it shows an intention to continue the full work instead of a desire to reduce it. If, when stokers are engaged, an arrangement is made with them that carbonizing shall not be carried on, unless through exceptional causes, they would be quite willing to undertake the work, when necessary, at an ordinary day's pay. At my works when this is necessary, I employ the yard-men. The stokers do not obtain more than two days' rest a month at the best, as they are at work on the Sunday nights during their fortnightly turn of night work. Since the carbonizing has ceased on the Sunday, the men have improved in *morale* and steadiness; and the returns obtained from the retort-house give every satisfaction.

In the year 1885 I read, at a meeting of this Association, a paper upon the avoidance of stopped ascension-pipes.* I then stated that the only perfect cure I had been able to find was an arrangement by which a continuously dripping stream of water was trickled down the ascension-pipe. This I have still in use with every bench of retorts. Whenever there is a cessation in the water supply, the pipes at once begin to clog; but since the day the arrangement was fixed, we have never been troubled with any of that hard pitchy stuff, the removal of which previously made retort-house life almost unbearable. It adds not only to the comfort but very much to the profit, as the keeping of these pipes clear enables the gas to pass freely from the retort. The make per mouthpiece is even; and the heats are regular. The usual production from each retort (⏢-shape, 9 feet long, 21 inches wide, and 15 inches high) is over 6600 cubic feet, and often 7000 feet, in the 24 hours.

This year will be memorable as the last whole year in which the full City coal dues are payable under the old Metropolitan Act of Parliament. There will no doubt be a strong struggle on the part of the authorities to obtain a new Act to enable them to charge tolls somewhat on the same lines. The daily press is

* See "Reports of Gas Associations" for 1885, p. 253.

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divided upon the question. The *Standard* in an article written early this year was in favour of maintaining them under somewhat altered conditions; whereas *The Times* on the same day had little to say in commendation of them, and in closing the article described them as "doomed." In years gone by, when all coals came to London by sea, and the conveniences of the River Thames were necessary to discharge them, and to send them on to their different destinations, there was some reason for these tolls. But at the present time they are militating against all industries in the Metropolis where coal is a necessity, and driving them away from its locality. London has quite enough to pay for the carriage of its coal, which is often more than its prime cost, without having heavy duties placed upon it. In Suburban London, it would be utterly unfair to tax the places again with tolls from which they receive no benefit whatever, and have about as much to do with them as they have with the city rates of Timbuctoo.

Sanitation is an ever-progressive science. One of its unsolved problems has been the disposal of the gases in the sewers. I am glad to see coal gas is again coming to the front on this important matter, and is going to solve the unsolved. For some time we have heard of Mr. Keeling's system for ventilating sewers, whereby he proposes to eject the sewer gases by means of a coal-gas burner placed in the base of a column with a revolving cowl upon the top.* The burning gas draws the gas from the sewers; and in its passage through the chamber heated by the former, the deleterious qualities are completely destroyed, and, by means of the cowl, the burnt air is passed on into the atmosphere. I have seen the apparatus at work at Ealing; and from the report of a Local Board Engineer, it seems to be answering its purpose well. Ventilation of sewers in the past has been often worse than no ventilation—the evil being simply distributed in the atmosphere, instead of allowing it to remain where it would perhaps do less harm. I have noticed over and over again that when the common method of sewer ventilation is carried out, there is a constant correspondence in the local press as to the extraordinary compounds of smell that are to be found in the neighbourhood of the ventilators. Mr. Keeling claims to destroy a very large quantity of gas with each of these burners; and according to theory, I believe he is right. He says that the rapid passage from the sewer of the gas intensifies the heat of the burner, so that it is able to consume however much may pass through it. The burner is constructed to consume about 5 to 8 cubic feet per hour; so that the cost of the gas will be but trifling. It will no doubt need,

* For particulars as to this appliance, see *Journal of Gas Lighting*, Vol. LI., pp. 148, 186, 482.

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for it to work efficiently, that the sewers should be districted; but this is always necessary where any attempt at proper ventilation is made. I think that this invention has a great future. It is a sightly object, having the same appearance as an ornamental lamp-post; and its effect seems to be perfect.

We stand to-day face to face with a state of things in the social management of gas undertakings which will have to be grasped by every engineer and manager. Whether there is truth in the statements made in the daily papers as to the amount of money received by our profession in the form of improper commission, or, speaking plainly, as bribes, there can be no doubt that a considerable amount of this illicit and illegal business is carried on I can only express my thanks to the Editor of the *Journal of Gas Lighting* for his powerful articles on this subject. I felt after reading them, that I was compelled to say *peccavi*, in that I had taken no active part in condemning such unrighteousness, but had been simply content not to do so myself, and so passed by these acts of perfidy in others. I do trust now that the public observation is stirring up our thoughts and considerations, the result shall be such as to cause the utter extinction of these malpractices. The matter will have to be sifted. Because in other commercial undertakings the same evil happens, and therefore it is not worse with us than with them, is reasoning that will not hold water. Many men from habit, and from following predecessors who have set the mischief going, have received and are now receiving that which they ought not to receive; and who upon consideration (the truth being clearly brought before them) will, I have no doubt, discontinue the practice at once. Others there are who will stick to all they can lay hold of, until it is wrested from their grasp, or until they are tabooed by all honest men. This commission system must die. If it be a natural death, so much the better for all concerned; but if not, means must be taken to crush it out. There can be no compromise. I observe that one large London Company has given notice that it intends to do business only with firms that will faithfully agree to have nothing to do with this system of commissions. I do trust that boards of directors and corporations, in this emergency, as they are supported by their officers, will not forget them, neither from a desire to increase the dividend nor to decrease the price of gas. The gas engineer's or manager's position is full of responsibility and anxiety, and should be recognized as such, and not paid for at the price of common labour. Rumours do fly abroad of directors, who were exceedingly liberal under the old conditions of things, becoming the veriest skinflints under the effect of the powers of the sliding scale.

In conclusion, I would thank Mr. Helps for the great care and

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trouble he has bestowed to make this meeting a success; and to ask you, gentlemen, to sustain him in his position of Secretary, in the same hearty manner that you supported me in days gone by.

Mr. W. D. CHILD (Romford): I rise to propose a vote of thanks to our President for his address this evening. He has referred to topics of great interest to us; and I am sure they well deserve our hearty consideration. To the processes of manufacture he has touched upon, we must give our careful attention; and the manner in which he has treated them will open up questions of interest. He has alluded to one subject—the question of commissions—which at present is exciting a great deal of interest among the gas community. There is no doubt that we should all—and all are, I hope, anxious to—live as honest men before the world. It has, however, appeared to me sometimes whether there is not more being made of this matter than should be made by the leading organ of the profession—whether we are not holding ourselves up too much before the public, and asking for too much criticism. I do not think any of us would desire to rest under the stigma of taking commissions for the wrong transaction of business. But it is almost questionable whether there may not be something of pharisaism crop up amongst us; and we may hold ourselves up as being too righteous. Perhaps it is not proper to criticize the remarks that have been made by our President in this way; but I will ask you to thank him heartily for the manner in which he has dealt with the various subjects he has brought before us in his interesting address.

Mr. GEORGE LIVESEY: I have been asked, Sir, to second this vote of thanks. I think that perhaps it would be better in future that some younger member should be asked to undertake this duty—not that I have any objection to it, nor that I have any desire to shirk it, because it is a duty that one can perform with the greatest heartiness. I am quite sure, Sir, that in your position of President you will do as much honour to the Association, as you have done to it in your position as Secretary; and the excellent address with which you have favoured us on the present occasion only gives us a promise of what you are going to do for us in the year to come. We can all join most heartily in the vote of thanks for that address. I am not going to criticize it in any way; but perhaps I may be granted a little latitude, and I may be allowed to say one or two words in reference to the subject which the worthy proposer of this vote has mentioned. I believe that the conductors of the *Journal* (which is an honour to the profession) are not going too far in what they say. I believe—I am very sorry to be obliged to believe—that they have information

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which we do not possess. Honest men such as the proposer of this resolution would have very little experience or very little knowledge of what is going on in the world; but if we can get behind the scenes a little, and if we can have as I did last week, an experienced traveller telling me how a large business has been built up by the modern principle, one ought to say—by these commissions—it makes us believe that what has been said has not been too strong. Perhaps Mr. Child and others have not had commissions offered to them; but that is no measure of what is done. Therefore I feel that it is the bounden duty of every man in the profession not to attempt to underrate the gravity of the case, but to do all he can to stamp out such an iniquitous system—iniquitous to the traders, and highly detrimental to the great number of honest men that exist in the gas profession. I have heard of this in other professions; and I believe that the gas profession contains as many—I am inclined to think it contains a larger proportion of honest, fair-dealing men than any other business that you can meet with. I know that the gas business, as far as dealings with our consumers are concerned, will compare in honest trading with any other business in the kingdom; and therefore, if we set our faces against this system, I believe we shall be able to stamp it out. Pardon me for this digression; and let me ask you now to join heartily in a unanimous vote of thanks to our President.

The motion was carried with applause.

The PRESIDENT briefly returned thanks, and the business portion of the meeting concluded.

The members afterwards dined together.

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MIDLAND ASSOCIATION.

ANNUAL MEETING, FEB. 16.

This Meeting was held at the Grand Hotel, Birmingham—Mr. HENRY HACK, M. Inst. C.E., Engineer of the Saltley works of the Birmingham Corporation (the President), in the chair.

The HON. SECRETARY (Mr. W. R. Cooper, of Banbury) opened the proceedings by reading the minutes of the previous meeting.

PROPOSED LECTURES AND CLASSES ON GAS MANUFACTURE.

The PRESIDENT: The only matter arising out of the minutes of the last meeting is a very important one. Mr. North suggested that once a year a lecture on matters of special interest to the gas industry should be arranged for in connection with our Association; and the Committee were to consider and report on the proposal. They have had the matter under their careful attention, and have come to the conclusion that it is very desirable to appoint a Sub-Committee to co-operate with the Committee appointed by The Gas Institute in regard to this important question of lectures on gas manufacture. They have heard unofficially that there is a probability of Mr. Foulis's suggestion (at the Glasgow meeting of the Institute) being carried out; and your Committee therefore think we should not be backward—that we should, in fact, take the first step by forming a Sub-Committee and assisting in furthering the ideas of the Council of the Institute, of which we shall hear in due course. They wish me to propose that a Local Committee of five members, including the Honorary Secretary and Treasurer, be appointed to take all necessary steps for the establishment in Birmingham of lectures and technical classes on gas manufacture, and that a sum not exceeding ten guineas be placed at the disposal of the Committee, to be expended in furtherance of such object; and, with your permission, I propose that.

Mr. J. ANNAN (Wolverhampton) seconded the motion.

Mr. H. PEATY (Burslem) said he did not see what the lectures had to do with The Gas Institute. When this matter was proposed, nothing was said about combining with the Institute as to lectures; and therefore he thought they were going away from the original proposition.

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The PRESIDENT said he believed it was in consequence of Mr. North knowing what was taking place at the Institute.

Mr. NORTH: Perhaps some explanation is due from me, seeing that I took the initiative in bringing this matter to the front. After making the proposition here, someone did me the honour of nominating me as a member of the Sub-Committee of The Gas Institute to consider the question of having lectures and technical classes at certain centres in the country. What will be the outcome of the meeting of that Committee it is impossible for me to say; but I think we cannot do wrong in putting ourselves in communication with the Council, and making some such offer of co-operation as is proposed to-day. And if the Council lay a fair and sound scheme before the meeting of the Institute in June next, I am sure the Midland Association will not fail to bring their influence to aid the Council in their endeavour to carry it out. As the report of the Sub-Committee has to be submitted to the Council for their approval or otherwise, I cannot give the details of the resolution.

Mr. PEATY: That is an explanation which will very well meet the case; but I think the members generally did not know it. I shall have great pleasure in supporting the motion.

Mr. C. HUNT (Birmingham): Mr. North has, I think, made it quite clear that we have much more to gain by co-operating with The Gas Institute, than by working independently in this matter. The proposition will, I think, meet with general acceptance, especially coupled with the suggestion that the lectures shall be open and free to members and associate members of the Institute, to all other *employés* in gas-works on the payment of a small fee, and to none others. In connection with this subject, I may mention that I communicated with our Gas Committee as to the possibility of the establishment of lectureships in Birmingham—thinking it possible that many of its *employés* would be desirous of attending any lectures that might be provided, in the event of which it must be desirable to secure the co-operation of the Committee. I am glad that the suggestion I threw out for their consideration has met with approval; and the Committee are prepared to pay to the lecture fund a capitation fee of 5s. for each *employé* of the Gas Department who is a regular attendant at the lectures; the total amount of such fees not to exceed £10, and not in any sense to be regarded as in commutation of the ordinary fee, but as a contribution to the general fund. With such co-operation, coupled with the assistance of The Gas Institute, we can do more than the small amount disposable from our own funds would enable us to accomplish. Probably The Gas Institute may not be disposed to pay more than half the total cost of the lectures; leaving the other part to be defrayed by local effort,

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which will not, I think, be found wanting. Perhaps the natural course will be to leave the management of the classes very much in the hands of the Committee that may be appointed by, and subject to the control of The Gas Institute.

Mr. C. S. ELLERY (Bath): I should like to ask whether this sum of ten guineas is supposed to be the only charge on the Association for this scheme. I see we have rather overcharged our income this year; and if the ten guineas is an annual draft, it will tell its tale on our balance in a very few years, unless some arrangement is made for meeting it.

The PRESIDENT: I gather it will be a standing contribution, if the object in view is to be carried out. I am certainly of opinion that we shall be doing very much better by co-operating with The Gas Institute than by acting alone in this matter.

Mr. HUNT: Allow me to point out that the resolution does not cover an annual grant; but one for the current year only. I think the vote should come up for discussion each year.

The PRESIDENT: Before I put the resolution, I should like to state that Mr. Hunt has been good enough to hand over towards this object two guineas he received for some literary work.

After some further remarks, the motion was put and carried.

The President, Honorary Secretary, and Treasurer, and Messrs. W. North, B. W. Smith, W. Littlewood, and Charles Hunt were appointed as the Committee.

The PRESIDENT next moved that the best thanks of the Association be forwarded to the Gas Committee of the Corporation of Birmingham, for their readiness to further this scheme, as conveyed to the meeting by Mr. Hunt; and also that their best thanks be given to Mr. Hunt for his handsome contribution to the fund.

Mr. B. W. SMITH seconded the motion, which was carried.

NEW MEMBER.

The PRESIDENT proposed the election of Mr. George Poole, of Sutton Coldfield, as a member of the Association.

Mr. TAPLAY seconded the motion, and it was carried.

THE REPORT AND ACCOUNTS.

The following report of the Committee (together with the accounts) was then presented:—

In laying before you a report for the past year, your Committee express their satisfaction that there has not been any lack of interest in the work of the Association. Three meetings were held, at which the attendance was well maintained.

The number of members on the books is 60. Four were elected during the year; two having withdrawn.

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Although the payments have exceeded somewhat the income of the year, the financial position of the Association continues satisfactory; the present balance in the bank being £71 2s. 4d., and the amount of unpaid subscriptions £5 15s. 6d.

The annual meeting was held at the Saltley Gas-Works, Birmingham, on Feb. 10, when, after the usual preliminary business, the President delivered his Inaugural Address, in which the "Depreciation in the Value of Coke and other Residuals," with suggestions for obtaining best results and prices, the "Question of Differential Rates for Day and Night Consumption," a "Review of the Progress made in Gas Manufacture and Plant," and the "Electric Light," were the principal subjects touched upon.

The President then, on behalf of the members, presented Mr. W. North with a marble clock and bronzes, together with a ring for Mrs. North, as a slight token of their esteem and high appreciation of the long and valuable services rendered by him to the Association as its Honorary Secretary. On the completion of the business of the meeting, at the invitation of the President the members inspected the works, where several settings of retorts to which gaseous firing, without recuperation, was applied in a simple and inexpensive form, and the stoking machinery were objects of especial interest.

The spring meeting was held on May 5, at the Engineer's Office, Millstone Lane, Leicester. There was a good attendance; and after the members had been very kindly welcomed by Alderman Wood and Alderman Barfoot, Mr. Alfred Colson, the Engineer and Manager of the Leicester Corporation Gas-Works, read a most interesting paper on "The Leicester Gas Undertaking;" tracing its history and progress from 1821 until the present time. He also spoke of the system of regenerative furnaces now in use there, and the continued success of the letting of gas-stoves on hire. After the completion of the business of the meeting, the members visited the gas-works, together with the new chemical and tar-distilling works, all of which appeared very well designed and substantially built; and all were highly commended. Several places of interest and antiquity were subsequently visited; the members fully appreciating the general arrangements and the kind reception accorded to them.

The autumnal meeting was held at the Grand Hotel, Birmingham, on Sept. 29, when Mr. Henry Hack was unanimously re-elected President. The other appointments made were: Treasurer, Mr. Simpson (re-elected); Honorary Secretary, Mr. Cooper (re-elected); Members of Committee, Messrs. Reeves and Taplay; Auditors, Messrs. Littlewood and Tew. Mr. Herman Taplay, of Stoke-upon-Trent, then read a useful and interesting paper on "The Automatic Regulation of the Exhauster-Engine," and Mr. Charles Hunt, of Birmingham, a very valuable and exhaustive one on "Differential Prices for Day and Night Consumption of Gas," both of which papers were highly appreciated, and led to an interesting and valuable discussion.

The PRESIDENT, in moving the adoption of the report and accounts, referred to the financial position of the Association, and said he thought the Committee were right in considering it to be satisfactory.

Mr. HUNT, in seconding the motion, pointed out the importance

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of keeping the expenditure within the income, particularly as the Association were about to embark on other matters likely to be of advantage to the members, but which could not be unattended with expense.

The report was adopted.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—Nothing has ever so forcibly brought to my mind the truth that "*tempus fugit*" than the fact that twelve months have already passed away since I had the honour to stand before you in fulfilment of the annual duty appertaining to the office which, through your kindness (and for which I sincerely thank you), I have for the second time the privilege of occupying. Probably to many here besides myself it appears but as yesterday. The fact, however, remains that in the interval the cycle of the seasons has been accomplished; affording us another fitting opportunity of looking back and inquiring if in our collective capacity, as well as individually, we have during the past year done all that lay in our power to further the objects of the great and important industry in which we are engaged. Whatever the result of such inquiry may be, I am sure we shall not rest satisfied; but that one and all will endeavour during the year we have entered upon to make further way along the path of progress, and to raise our calling a step or more higher in the category of the learned professions, and in the estimation of the world.

As regards part of the suggested inquiry, the annual report, which has just been received, recalls to our minds the work which the Association has publicly done during the year; and if the number of papers read and discussed were taken as the sum-total of the good achieved, I am not sure that we should have cause for any special congratulation. Happily, however, this is not the only standard by which such question is to be solved; for desirous as we all must be that there should be no lack of papers forthcoming for our meetings, I feel that no one of us under-estimates the additional benefit which accrues from the free exchange of views upon various matters relating to our industry, which regularly takes place in a semi-private and informal way on the occasion of these and kindred gatherings, of which I am ready and pleased to admit I have derived no inconsiderable share. While saying this, and while again wishing to record my own thanks to those members who so willingly contributed the able papers last session, I must add that, in view of our meeting but thrice a year (instead of four times, as originally intended), the Committee would gladly welcome, and are anxious to obtain, at least two papers per meeting. Perhaps

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you will kindly bear this in mind, and that "offers" are even now wanted. It is not at all necessary that the subject should be a new one, nor the paper a long one; in fact, short accounts of feats accomplished, difficulties overcome, failures as well as successes, relating to any particular item of the operations or part of the plant at the works of the respective members, would I am sure be interesting as well as instructive and profitable information, not only to ourselves, but to many of the profession outside our own Association; and I trust this hint may be deemed worthy of consideration by the members generally, and especially by those who, for want of time or other causes, have not hitherto seen their way to assist with communications of a more formal character.

It has occurred to me, as it has probably to others, that the utility of Associations like ours might be enhanced if a Special Committee, composed of say three or four of the members, were appointed from time to time (as required) to investigate and report upon new processes and inventions which, in the opinion of the Ordinary Committee or members generally, appear to contain the elements of success, and which if successful would be an important source of gain, or otherwise result in advantage to the industry. Valuable and reliable as are many of the records of the experiments made by individuals, I am of opinion that a joint and unanimous report of such a Committee would carry still greater weight, and be deemed perhaps more conclusive upon the subject investigated. Such a course should render unnecessary the labour and expense now often incurred by the sceptical in verifying, for their own satisfaction, the results which are published from time to time—some of which, emanating as they now and then do from interested parties, are naturally, although perhaps unwarrantably, open to suspicion. This suggestion is not intended to apply to minor matters, which may still be well left for individual inquiry and research, but only to such proposals as require a considerable amount of time and expense to put their value or otherwise to a practical test.

Again, inquiry and research would, I think, be materially assisted, and a large amount of unnecessary duplicate expenditure prevented, if Companies and Corporations would form an Association and a fund for the purpose. Such an Association could decide at what works experiments relating to inventions, or proposals deemed by the profession worthy of serious consideration, should be carried on at their joint expense by the Engineer of the works selected, in conjunction with the Special Research Committee of the Local Association augmented by others appointed by The Gas Institute, together with such further assistance from experts as might be found desirable to render the accuracy of the results

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obtained, and the conclusions arrived at unquestionable. I am induced to attach importance to steps of this kind being taken, feeling that all the improvements and advantages which Science and the inventive geniuses of the age place at our disposal are not reaped to the full extent; and progress is therefore retarded through the not unnatural disinclination of Committees and Directors to incur the responsibility of expending money in relation to new departures, which (like others before them have done) may prove failures or worthless in practice, although from a theoretical point of view there was every indication of success. Knowing from experience, as I do, how scantily their successes are rewarded, and the amount of opprobrium meted out to them in case of failure in their efforts to still further promote the interests they watch over, one cannot be surprised at the lethargy that not infrequently exists in relation to suggested improvements.

There are also many matters in connection with the existing operations of gas manufacture which require further investigation, and upon which the services of such a Special Committee as above portrayed might be enlisted with advantage. Among them I would particularly allude to "Naphthalene Deposits and Stopped Pipes; the Cause of their Formation and Prevention." The former subject was dealt with in a very full and able manner by M. Brémond in a paper read before the Société Technique de l'Industrie du Gaz en France, at Rouen, in June, 1877*; since which I am not aware that the subject has been treated upon by anyone at any length. Many are still in doubt as to the means necessary: (1) To prevent or minimize its formation; and (2) when formed, its leaving the works so as to avoid the nuisance and expense attending its deposit in the service-pipes and fittings. The question is a very complex one; for one hears of different works at which practically the same kind of coals are used, the carbonizing carried on at like temperatures, and the method of condensation, nearly (if not quite) identical, where in some cases trouble with naphthalene is unknown, either at the works or in the district of supply, while at others the nuisance is prevalent to a large extent, particularly in the district at various periods of the year, but more frequently during the summer and autumn months. A few years ago its appearance very rarely occurred where Midland coals were employed; but the result of some recent inquiries is that further experience proves that this class of coal can no longer be relied upon for immunity from the evil. That the quality of the coal used, the thickness and evenness of the layer, the duration of the charge, and the temperature at more stages than one, play an important part in this naphthalene question as well as in the

* See *Journal of Gas Lighting*, Vol. XXX., p. 491.

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direful matter of stopped ascension-pipes, I have not the least doubt; but that in respect to both there are other contributory causes, from my own observations, I am equally sure. I have not, however, hitherto been able to determine them with any degree of satisfaction; the hopeful augury induced by the experiments of to-day being dashed to the ground by results subsequently obtained under (to all appearance) like conditions.

As our friend Mr. R. O. Paterson has promised to touch upon the subject of stopped pipes at our May meeting, I will not just now enlarge upon this matter myself, but trust that his communication, and the discussion which I hope may follow, will assist us in arriving more nearly at the real cause or causes of this terrible bugbear (which, apart from the great waste and cost that it entails, disturbs so materially the happiness and comfort of the men and masters alike), and indicate a less rugged, if not the preventive road.

While referring to the foregoing two subjects, I am led back to the able and instructive remarks of Mr. Foulis in his Inaugural Address to the members of The Gas Institute at Glasgow last year, in reference to the processes which go on in the retort during distillation, the influence of temperature upon the character of the gases produced, and also to this matter of stoppages in the ascension pipes—all forming a most welcome addition to our stock of knowledge upon one of the most interesting stages of gas manufacture. The record may, I am sure, be referred to frequently with advantage. A large amount of labour and patience is thereby shown, without which, however, such experiments as he explains cannot, of course, be made; and although, as a rule, gas managers have but little time to devote to other than the usual routine of the works, I am convinced it is only by pursuing investigations of this kind that we can hope to lessen our difficulties, reduce the cost, and improve upon the present conditions of manufacture. Consequently any time that can possibly be spared for the purpose cannot, in the interest of the profession be more usefully employed

I would also add here my appreciation of the interesting paper by Mr. C. W. Folkard, on "Carbonizing," read before the Southern District Association early in November last, which (with the discussion arising out of it*) is well worthy of careful study. When we know from our experience that, with experimental plant on a fairly large as well as a small scale, we often obtain as uch as m11,000 cubic feet of over 17-candle gas, or a multiple of from 190,000 to over 200,000 from coals which when carbonized in our retort-houses only produce 10,000 cubic feet (or even less) of the same quality,

* See "Reports of Gas Associations" for 1887, p. 272.

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or say a multiple of about 172,000, we must I think be unanimous in the opinion that we have not as yet nearly reached the acme of perfection in the matter of carbonization; but that admitting the improvement which without doubt has taken place—of late years especially—in all details of gas manufacture, much remains to be done, and it behoves all of us to contribute to the utmost of our power and ability towards the balance outstanding.

This is not an age to rest on our oars with contentment; the millennium has not yet been reached. There is still work to be done; and as in the past most of the successes in engineering, chemical, and other sciences have been the outcome of careful thought and experiment (thwarted now and again though it may be by failure), so it must be now and in the future. If we are not to be left behind in the race, we must not shirk such work; experiments, costly or otherwise, must be continued in spite of reproach in case of failure. We must have no standing still; but like the snowball which in my youth I enjoyed to see become greater and greater as it was rolled on, so must we as years roll by aim at picking up and adhering to all that shall tend to increase the magnitude, importance, and utility of the industry which we represent.

The valuable statistics published by the order of Parliament in the returns relating to gas undertakings afford us a good general idea of the progress made from year to year; and apart from the evidence deduced from the present market value of gas shares and stocks, they show how deeply and widely rooted the gas industry has become and the enormous proportions to which it has attained. In spite of petroleum, electric lighting, and illuminants in other forms, coal gas not only maintains its own but a steady increase in the consumption continues; and this notwithstanding the dulness of trade, and the praiseworthy special efforts of the Electric Lighting Companies to extend their field of operations principally during the period covered by the returns—viz., from 1882 to 1886 inclusive.

Without anticipating that I should be forestalled, as I now find I have been, by ıe recent article upon this subject in the *Journal of Gas Lighting*,* I had for the purpose of this address taken some little trouble in investigating the figures recorded; and having dealt with the matter in a somewhat different form, I still hope it will not be uninteresting if I briefly refer to some of the more important of them. As it is well known that the returns only include statutory undertakings, the evidence deduced from them is in many particulars, as affecting the whole industry, somewhat less conclusive than they otherwise would be; but if the

* See Vol. LI., p. 141.

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figures relating to the non-statutory companies could be added, I do not suppose the results would be materially affected.

In 1882 the number of gas undertakings in the hands of local authorities was 149; in 1886, 164—or nearly 10 per cent. increase. Belonging to companies at the same dates (adding those absorbed by the Chartered and South Metropolitan Companies), there were 365 and 390 respectively—increase 6·8 per cent. Those who advocate the retention of the gas supply in the hands of companies may take comfort from these figures; for they show that as yet only 30 per cent. of the statutory undertakings belong to local authorities, and that, whereas these bodies have only acquired 15 during the four years, the number of companies has increased by 25. There can be but little doubt that, immaterial as is the extent to which it has encroached upon the domain of gas lighting, electric lighting has had a share in cooling the ardour of local authorities to disturb private enterprise; but I believe that the principal opposing forces have been the operation of the auction clauses whereby, taking premiums into account, capital is raised (even without the aid of the additional premiums due to the sliding scale) at about 4½ per cent., or only about 1 per cent. more than the average of local authorities could obtain it for. This leaves, compared with former times, but very little margin with which to cover the risk so often talked about. The enterprising spirit which has pervaded most companies of late to reduce the cost of manufacture to a minimum, consistent with keeping the works in a state of efficiency, so as to enable them to supply gas of good quality at the lowest rate, has also, I think, contributed to induce many of the local authorities to let gas alone.

It is said that "comparisons are odious." To some they may be; but they are nevertheless often useful. Let us therefore, in the light of these returns, compare the results of the companies with the undertakings of local authorities.

In 1882 the former, dealing still with the United Kingdom, made an average of 10,014 cubic feet of gas, and sold 9230 cubic feet per ton of coal; the results for the authorities being 9873 and 8983 cubic feet respectively. For 1886 the figures for the companies are: Make, 10,220; sold, 9399. Local authorities: Make, 10,029; sold, 9157. Although these figures show that, in both these respects, the companies carry off the "palm," it is gratifying that there has been a marked improvement in the yield and sale per ton of coal all round. The gas used on works and "unaccounted for" is about 1 per cent. more in the case of the local authorities than with the companies. Excluding Scotland (where cannel gas predominates), the average illuminating power of the gas supplied by the companies was 16·0 candles in 1882, and 16·2 candles in 1886; whereas the local authorities gave gas of an average of 16·5 candles

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in 1882, and 17·3 candles in 1886. These figures adversely affect the stock argument so often, without justice, made use of, that "the gas is not so good as it used to be when supplied by the company;" and if we take both make and illuminating power into account (multiplying one by the other), which is the fairest way, the comparison becomes then about 4¾ per cent. in favour of the local authorities.

The enormous total quantity of coal that was carbonized throughout the United Kingdom in the year 1886—viz., 8,657,731 tons, an increase of no less than 1,376,974 tons since 1882—may have well struck the many thoughtful men who have set themselves to work out the problem as to how long our coal-fields will last. I believe the most recent calculation was such as to assure the very youngest of us that the question of finding a substitute would not crop up in our day. Such a fact, having regard to the various other "drains" upon the supply (beyond the requirements for gas making), must impress upon all the enormous "mine of wealth" that still exists in the coal-fields of our country.

The total increase in the gas sold throughout the United Kingdom for the four years dealt with has been a healthy one—viz., 21·1 per cent.; or at the rate of 5 per cent. per annum compound. Therefore what is usually considered as the average normal rate has practically been maintained, in spite of all friends and adversaries; the increase in the areas supplied by local authorities having been a little more favourable of the two classes—viz., 5½ per cent., against the companies 4½ per cent.

With regard to capital expenditure, as in the case of local authorities the sum includes whatever amount was paid to the companies for "goodwill" at the time of purchase, the total outlay per ton of coal cannot be fairly or closely compared with the expenditure of the companies. But by another process, one can see if in each class we have been able to economize; and, according to the figures, this is so to a most gratifying extent. Excluding the undertakings where the capital includes the outlay on both gas and water, and eliminating also the fifteen transfers between 1882 and 1886 inclusive, and consequently the doubtful elements as to how much of the capital represented by them was for goodwill, &c., I find that the relative cost per ton for the new business of the four years is as follows:—

Companies: England,	£3	16	6;	United Kingdom,	£4	1	6	per ton.
Authorities:	„	3	17	4;	„	3	10	7 „

Or a reduction in the case of the English companies from the cost in 1882 of no less than £2 14s. per ton, and of £3 12s. 5d. in the case of the English local authorities. But, owing to the goodwill item, these last figures are incomparable with those of the companies.

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There still remain disturbing causes deterring us from accepting the above figures as representing the true cost of works and mains, &c., for the increased production within the period dealt with—such as surplus power at 1882; and, where expenditure has since taken place, the probability of provision having been made for a term extending considerably beyond 1886. Another important feature which renders a comparison of remote and recent capital expenditure as shown by these returns still more unreliable, is the absence of information as to the extent to which both companies and local authorities may have "wiped off" capital by way of depreciation, and also as regards the amounts actually expended on extensions out of revenue.

The returns show that the premiums realized by statute under the auction clauses amounted in England in 1882 to 4s., and in 1886 to 4s. 10d. per ton of coal carbonized. Also that in 1882, 68 companies had adopted the sliding scale; this number having increased in 1886 to 101.

By reason of the varying discounts allowed, and the want of uniformity in respect to charges for meters, one cannot, without a very tedious amount of work, arrive at an exact comparison of the average cost of gas to the consumer. These items might or might not materially affect it; covering as it does so large an area. Omitting them, however, from the calculation, the figures for 1886 are as follows:—

	Companies.		Authorities.	
	s.	d.	s.	d.
England and Wales	3	10·8	3	5·1
Scotland	4	5·7	4	0·4
Ireland	4	6·5	4	8·0
United Kingdom	3	11·16	3	6·4

I trust I have not wearied you in thus shortly touching upon these statistics. I was induced to do so thinking that we should be better able, in this way, to form a more accurate idea of the progress our industry has made during a period of great trade depression, than by limiting the investigation to any particular town or section of the country. I append, in tabular form, the figures given above, together with a few other particulars deduced from the same returns, some of which, if not all, I trust may prove useful for reference.

These and other returns relating to gas made and sold would be rendered more valuable for comparison if the same method of measurement at the works were adopted. The statute simply provides a *form* for these particulars; but for the "make" of gas some companies and authorities take the registration of the station meters pure and simple, while others correct this record to one uniform

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temperature—60° Fahr.—which may cause an important difference in the figures for yield per ton of coal, and materially affect the "unaccounted-for" quantity. The Metropolitan Gas Referees reduce all the results of their testings to a uniform standard of 60° Fahr. temperature, and 30 inches Barometer; and for the sake of uniformity and value of comparisons, I think it would be well if we all adopted this plan. I may here mention as an illustration that at one of my own works the effect of adjusting the measurement of the station meters to 60° in 1886-7 was a reduction in the recorded yield per ton of 238 cubic feet; while at the other, in the same period, it increased to the extent of 94 cubic feet, making a difference of 332 cubic feet per ton as between the two works.

There can be but little doubt that the adoption of the sliding scale has had a beneficial effect upon the returns of many of the Companies; in fact, that by it a fillip was given to the gas industry just at a time it was wanted to meet the predicted onslaught of the "Light of the Future." It must have brought about great economies in working, by which the consumers and shareholders have both greatly benefited; and it places the management of gas companies on a par with that of corporation undertakings, where (there being no fixed dividends to regulate their efforts) the continual aim is to lessen the cost of production to the fullest extent, so that the consumers may enjoy all the advantages of cheap gas, and the ratepayers, be they consumers or not, reap a fair reward for their outlay.

In the days of the companies' old system of maximum dividends, whereas the corporation gas engineer was expected to produce, by the aid of modern improvements and science, the very best results obtainable, the company engineer, on the other hand, suffered no great anxiety so long as the public remained silent, and the profits were large enough to pay the statutory dividends and other monetary liabilities. Beyond the natural desire to compare favourably with one's neighbour—the dividend being assured—there was then no special stimulus to economize; and the figures given by Mr. George Livesey at the Glasgow meeting of The Gas Institute, prove that in former times gas was not in many cases made and supplied as cheaply as was possible, nor was capital expenditure (in spite of the inducements that then existed to pay for extensions out of revenue rather than lower the price of gas) kept as low as it might have been. When first adopted, the sliding scale may tend to create a cheeseparing policy, both in the matter of repairs as well as new works, which could, however, only be carried on for a time. The day of reckoning would in such cases surely come; and, with it, regret and remorse for having pursued such a "penny wise and pound foolish" course.

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The truest economy will be found in continuing to have a due regard to the stability and durability of all new structures, and in systematically maintaining all the works and plant in a perfect state of efficiency. That the introduction of the sliding scale has been the means of cheapening gas in many instances is, I think, unquestionable; and it has therefore done good service all round. But I cannot but recognize the fact that without its aid the same satisfactory results must have been achieved, with like benefits to the consumer, under the old plan of maximum dividends coupled with the auction clauses (without this stimulus of an increased dividend), if like energies had been put forth and a similar line of policy pursued in the conduct and management of the works. There is, of course, much virtue in the "if."

The very operation of the sliding scale shows clearly, I think, that it was possible for the maximum dividends to have been earned, the reserve fund maintained, and the price of gas made even lower than at present (to the extent at least of the amount paid in dividends upon the original capital in excess of the old statutory limit); only there lacked the all-important inducements. The matter affords an example of the "payment by results system," which has, on more than one occasion, been advocated in respect to gas engineers and managers; but for my own part, in this case also, I fail to see that any advantage would accrue thereby, either to our employers or ourselves, if we are already doing our best (and which I hope I may say is the case with all of us) in the interest of the undertakings with which we have the honour to be connected.

It is very gratifying to be able to record that the special efforts inaugurated at the time of the Edison electric light "scare," to improve gas-burners and the design of gas-brackets and gaseliers, continue, and to note the great advance which has been made since then in the duty, or in other words candle power, obtainable per cubic foot of gas. A great and important step was made when it was shown by the improved Argand burner, which has ever since been adopted as the "standard burner," that gas which, when consumed in many of the various burners at the time in use, produced but from 1½ to 2 candles per cubic foot, was capable of developing from 3¼ to 3½ candles per cubic foot when burned under more scientific and favourable conditions. Satisfactory as the results were deemed at the time, they have long since been surpassed and perhaps "looked down upon" with the introduction of burners upon the regenerative principle, with which the name of Siemens will long be remembered. The obtaining of double the aforesaid duty is now considered no great feat; 7 to 10 and even 12 candle power per cubic foot having with

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this system been realized without reflectors varying according to the size of the burner and consequent consumption. By the aid of reflectors better results still are to be obtained; but for comparison it is fairer to exclude these useful devices.

Some manufacturers and inventors are still in rivalry for the honour of surpassing even such excellent achievements from the gas *per se;* while others are directing their attention to the more novel system of "incandescent" lighting by gas—stimulated probably by a desire to compete, where expense is no object, for the slight favour which has been shown to this kind of electric lighting for indoor purposes. Of this system, there are various forms (some designed for coal gas, others for water gas) with which I have no doubt you are all more or less conversant, so that there is no need to recall them in review. But it may not be deemed superfluous if I remind you that the object of this system is to utilize as a source of obtaining light, in conjunction with the heavy hydrocarbons of the gas, those constituents which in the act of combustion produce great heat but little light; the heat produced by the combustion of the whole of the constituents of the gas being made to act upon, and render incandescent, the refractory material employed. In the absence of a supply of ordinary illuminating gas, the water-gas method might, I think, be found a convenient if not so economical a substitute for oil or candles for large country houses and mansions; and for isolated factories, where the water gas could be used in connection with the manufacturing operations, it might even be found to be a cheap as well as an advantageous source of light, provided in all cases that the risk attending the use of an inodorous and poisonous gas like carbonic oxide can be minimized. Otherwise its introduction may turn out very "inconvenient" to the users. They have had proof enough of this in America, where from its effect so many have, in a quiet and unostentatious manner, been put to the "sleep which knows no waking."

But as coal gas engineers, I am anxious that our attention should not be too much diverted by these ingenious incandescent forms of lighting (with their paraphernalia of fragile "cones," "combs," "cages," &c.—beautiful specimens though they undoubtedly are of the result of much careful thought and experiment, and for which a field of utility may be found) from what should be our chief aim in this matter—viz., to get, in as simple a manner as possible, the largest amount of light from the incandescence of the carbon particles of the gas itself. To this end we must adopt and encourage the use of the most improved form of burners invented from time to time, suitable to the varying requirements of our customers, many of whom cannot incur the

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expense of high-power burners of the regenerative type. Many of the recent inventions have the drawback of being too complicated and too costly for general use. Manufacturers of such apparatus should cater for the million, as well as for the rich and favoured few; and in aiming at high efficiency, they should not, as many of them appear to do, lose all sight of simplicity and durability. Then if to these all-important attributes they can add cheapness, their wares are pretty sure to have a successful run. It will however, I think, be a long time before the improved flat-flame burners now so popular are superseded for general use. Either singly or when grouped, they are the most suitable burners extant; and in able hands, uncostly, yet very effective lighting on a large or small scale can be produced. But whatever the form of the burners adopted, we should continually impress upon our customers that they must not expect them like the brook to go on and last for ever, but that they should be overhauled, cleaned, and even changed occasionally. If this were done as systematically as "spring cleaning" is in all well-regulated establishments, defects would be discovered in due time, with the result that the consumer would be money in pocket, and the engineer and his gas spared from many a severe and unjust epithet.

I am of opinion that the gas lighting of our streets and public buildings would be much more satisfactory if the arrangements were entrusted to the gas engineer instead of, as is now commonly the case, being left entirely in the hands of the surveyors and others—many of whom (with due respect to the general ability of these gentlemen) have not had the requisite training to render them competent advisers in such matters. Moreover, by reason of their numerous other duties, they cannot have sufficient time to attend properly to this special work. In times like the present, when there is happily an increasing tendency to promote and cultivate "art" (emanating from the laudable desire to combine beauty with utility), these matters should have much more care bestowed upon them; and with but little extra cost, instead of the hideous and often lop-sided lamp-posts and antiquated lanterns prevalent in so many towns (London and several parts of its suburbs included), others might be provided of good design and proportion, light, elegant, and pleasing to the eye, whether seen by night or by day. Many of the Continental cities have stolen a march upon us in this respect, and very rarely erect any but really artistic columns and lanterns—at all events in their principal streets. Local authorities, to my mind, are generally much too cheeseparing in this matter; and, apart from the artistic side of the question, very frequently place the lamps too far apart for satisfactory results to be obtained. The electric light companies,

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judged by their recent attempts, are evidently alive to this; and hope to gain a point by improving upon such backwardness.

In the course of my address at our annual meeting last year, when speaking of the electric light, I referred to its intended introduction on a large scale at Leamington to celebrate the Jubilee Year of Her Majesty, and then quoted the terms that had been arranged.* The Year of Jubilee has passed; and the installation is still incomplete, and has—like all its predecessors during the last twelve years—been accompanied by the usual mishaps and interruptions in the supply. A week or two ago, a discussion took place in the Leamington Town Council upon the subject, when, among others, the following significant question was asked:—"If any steps are going to be taken to protect the public from accidents at various crossings, from the want of light at night?" One gentleman added that at a particular point in the area on one occasion, so far as an uneducated, unprejudiced observer could judge, the electric light was an absolute failure; and that one single gas-lamp there would have been of more value to the inhabitants of the borough than all the promises of the electric light in the future. It subsequently transpired that the Surveyor had already written to the Electric Light Company to the effect that "not another gas-lamp must be removed."

Although, as in other places, the application of this light is (when it can be kept going) successful "as a light" in the various shops as well as public buildings, I may say that I think from personal observation that, apart from the mishaps, this street lighting is so far very unsatisfactory in comparison with gas lighting. I am not surprised at this; for, in my last address to you, I alluded to the Holborn Viaduct experiment as an instance of the inapplicability of the incandescent electric light for outdoor purposes. It is not sufficiently diffusive; and at its best it possesses a dull, bilious, yellow tinge. In spite of the amended, better, and (I may say) more equitable and just terms afforded by the Board of Trade, another year has passed without electric lighting having made any marked progress. I certainly do not know of any additions to the few installations in this town; and although many are the efforts to simplify and cheapen the production and distribution where its application has proved successful, it still remains entitled to the appellations of "*lumière de luxe*" and "light of the future." In a much shorter period than has been allowed to the electric light, gas lighting, by its rapid growth, proved itself a success; extensions being unaccompanied by such subsequent failures in the supply, which unhappily still beset the efforts of the electricians,

* See "Reports of Gas Associations" for 1887, p. 19.

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and cause them to continually plead "novelty" of the system as the scapegoat. It is still difficult to get at a true comparative cost of Electric *versus* Gas Lighting. Sir David Salomons, however, has recently contributed some very interesting figures upon the subject (which were recorded in the *Journal of Gas Lighting* for Oct. 18 and 25 last year*); the comparative cost of different motive powers being fully and ably dealt with. His conclusions were that up to 100 lamps there is but little difference as between gas and steam engines, both in the matter of capital outlay and working expenses; but that gas-engines, "requiring less attendance," are to be preferred for small installations. For larger installations, the steam-engine carries off the palm; and we have no reason to be displeased with this opinion. The bulk of Sir David's calculations, being based more or less upon estimates and assumptions of (not ascertained) candle power, cannot be accepted as conclusive; and, in dealing subsequently with the comparative cost of the two systems of lighting, he is not very precise, for he shows that for 90 electric lamps, all charges included, the cost is £3 per lamp per annum, and gas (at the high figure of 3s. 6d. per 1000 cubic feet) £2 5s. per burner of equivalent power. But this, being too clear a case in favour of gas, even at that comparatively high price, he has taken the extraordinary course of saddling the gas with the cost of "candles and oil," which, he assumes, would be required in addition if gas were used; even then only bringing up the cost to £2 7s. against £3 for "the very best method of lighting by electricity." My opinion is, judging by the usual precautions taken by "having gas or oil in readiness" where electric lighting has been introduced, that this is a slip on the part of Sir David Salomons, and that the 2s. should really have been added to the £3; making the comparative cost £2 5s. for gas, against £3 2s. for lighting by electricity. Further, without showing how it is arrived at, Sir David Salomons says that, for a large installation of 150 lamps and over, the cost rapidly becomes less than with gas. But this cannot be the case; for, in the following paragraph, he proves the contrary. He there shows that, without anything for duplicate apparatus, which in some particulars has to be provided in gas-works, and which provision must be equally, nay even more, necessary as regards electric lighting, on account of the absence of adequate storeage, the cost is £3 13s. per lamp. But this is qualified by the following significant words:—"But in practice, so many lamps are rarely used at once; nor is the installation used all the year round. A saving is thus exercised, which has rendered the electric

* See Vol. L., pp. 701, 753.

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light far cheaper than if gas had been employed as a source of illumination." Gas engineers have, however, to lament the fact that much of their plant is idle for a long period of the year; and were it not for this, unlike what is stated above as regards the electric light, gas could be supplied at even cheaper rates than at present.

Upon this question of cost, the old adage "that doctors differ," and very materially, is once more exemplified; for Professor Ewing, who has just brought to a close a course of lectures at the University College, Dundee, stated that "the cost of domestic lighting was very great where each householder had to supply his own electricity; but that, by co-operation, it might be reduced to a moderate figure, though it remained, and apparently would remain, for some time dearer than gas—the cost of gas at Dundee being 3s. 10d. per 1000 cubic feet.

Before passing from this subject, it may be well to recall to mind that, according to competent authorities, there is but little, if any, room for improvement in respect of the amount of electric energy obtainable from the horse power developed at the engine; an efficiency of from 90 to 95 per cent. being, it is stated, commonly attained. It would therefore appear that the electricians' only hope of being able ultimately to approach more nearly the price of gas rests upon cheapening, without reducing the efficiency of, the machinery and distributing plant (as regards this last item, the recent enormous rise in the price of copper does not bid fair for such hope being realized), and the discovery of means for storing the power on a larger and much more economical scale than has hitherto been found practicable. This question of storeage is still, without doubt, a very serious and difficult problem for them to solve; and until solved in a practicable and satisfactory way, it must continue one of, if not the principal drawback to a successful system of electric lighting on an important scale. Before promoters are entrusted with the lighting of a large area of any town or city, I am of opinion that, in the interest of the community concerned, it should be compulsory upon them to prove, to the satisfaction of the authorities and their advisers, that at whatever hour darkness may (without notice, as usual) "come o'er the face of the earth," and whatever the fluctuation in the daily demand may be, they are not only ready to meet, but welcome it, as were gas engineers in the "week of fogs" ending the 14th ult. [Jan.], when, for their guidance, I may add that in Birmingham it varied as much as 56 per cent. The total output on Friday (24 hours) was 56 per cent. more than it was on the previous Monday; and I dare say many others could afford them similar comforting information. In lieu of ample storeage, much of the plant must be in duplicate, to the extent at least of that necessary to cope with the greatest hourly demand, in

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which case, I venture to think, their chance of success as a competitor with gas will be reduced to the "vanishing point."

Proud and thankful as we all must be for the great and wonderful things which electricians, by the aid of Science, have recently and in the more remote past accomplished, without which it is difficult to conceive how the vast business of the world could now be carried on, it would almost appear from the poor success, commercial and otherwise, with which they have hitherto been rewarded for their efforts in this matter of electric lighting, that they have started on the wrong track, or have *en route* become switched off the main line on to a crooked, rugged, and circuitous siding, upon which it is difficult indeed to make headway. Yet it is hard to credit that they who have achieved so much in the past, will not ultimately overcome the obstacles which now beset them—will not sooner or later reach the goal of their praiseworthy ambition to become the caterers of an additional good and reliable (if not cheap) artificial light. Be this as it may, the strength of our position, as indicated by the continuous demand for gas-engines throughout the country (which, from figures supplied to me, I find is very satisfactory), the multifarious and ever-increasing uses for which gas is required, bids us have no fear, but should enable us to really welcome any new outcome of Science which shall tend to the happiness and prosperity of the world. The past proves that, as time goes on, there will be found room for us all.

Our present greatest competitor in the matter of lighting is undoubtedly petroleum; and although just now we can scarcely hope to manufacture and distribute gas so as to afford as cheap a light as can be procured from this oil, it behoves us to remove all obstacles at present in the way of increasing our business, to take advantage of all discoveries tending to improve the quality and purity of our gas, and of anything that will lessen the cost of its production, so that the price to the consumer may be kept reasonably low. In this way we may not only hold our own, but, with certainty, reap a due share of the future requirements. Although petroleum may be cheaper, its use is attended with indirect expenses and inconveniences not unfraught with danger (the daily cleaning, filling, and trimming of the lamps among the number), to be free from which, many do, and others will, where they have the opportunity, readily pay such a sum as is represented by the extra cost of gas over oil, providing a wise policy as regards the fixing of the price of the former continues to prevail.

One step in the direction of popularizing gas among the poorer classes, who now so largely use petroleum, would, I think, be made, if the so-called "automatic" gas-meter, which is about to be introduced to our notice, were adopted. Under such an arrangement,

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"payments," as well as collection, would be made easy; and the deposits now naturally required, but which nevertheless tend to deter many from availing themselves of gas, might be dispensed with. I am of opinion that the scheme is well worthy of being afforded a trial. I advise, however, the promoters of this system of payment for gas consumed, to at once alter the name, which is really a misnomer; for, although erroneous, most people are apt to believe that the gas-meter is "automatic" enough already, and I am afraid that if such an appellation be adhered to, consumers of all kinds will fight very shy of it.

Foremost among the sundry matters to which the attention of the gas profession has been directed of late, stand the subjects of technical education and the repression of commissions. With regard to the former, you are aware that the outcome of the remarks and suggestions of the ex-President of The Gas Institute last year was the appointment of a Committee of the Council of the Institute to carefully consider and report upon the matter; and I have no doubt, having regard to the ability of the gentlemen of which that Committee is formed, that the subject will be, or has been already, ably dealt with, and in due course we shall be officially acquainted with the decision they have arrived at in respect to it. This question has not been confined to our own profession; but during the past year has been made a prominent one for the nation at large, and the Government has now pledged itself that it shall form part of this season's parliamentary programme. There cannot be two opinions that, looking at the matter broadly, if we are as a nation to hold our own—if we are to shine in the future as we have undoubtedly done in the years that are past, we must keep pace with the times. There is no doubt that this question has obtained the prominence it has, through a sense that we are beginning to lose ground in the competition with which we are now confronted on many sides. While we have been serenely counting alone upon our vast wealth and resources to enable us to continue to tower above other nations, there has existed on their part a steady and systematic method of art and technical training of the masses, whereby they have materially undermined our position and minimized the advantages we were so long in possession of. There can be no fixed standard for education—it must be progressive; and it does not follow that in the future there will be a "levelling up." In my belief, ambition will continue to exert itself, so that a similar disparity as at present exists will be perpetuated. The standard which has hitherto enabled many to stand head and shoulders above their less richly endowed and more unfortunate brethren, will probably have to be capitulated, not through weakness, however, but through a desire to "soar" from

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a sense that there are ahead objects of greater attraction and importance to grapple with and master.

There may be a diversity of opinion on the question as touching our own calling, to which I think the word "technical," as it was originally understood, could only have but limited application. But in the broader sense in which it has become the fashion of late to interpret it, it does, I think, apply with equal force as to other trades and professions; and I see no reason why those who, by birth or force of circumstances, have, at the outset of their careers, to undertake the more menial part of the operations of gas manufacture, should not have the means placed at their disposal of adding to the wealth of the nation by utilizing to the fullest extent the brain-power with which God may have endowed them. The Board Schools are a material help in this direction; and an extension of technical education will fill up the remaining gap. I can see nothing but gain and advantage in enabling the stoker to understand and take an intelligent interest in what takes place with the coal after he has placed it in the retort; inaffording the fireman the opportunity of understanding the principles of fuel combustion, the results produced from fuel consumed in an ordinary, as compared with the gases produced from those of the generator type, and the reason for the secondary air supply employed recuperatively or otherwise. Besides creating within them a lively interest in the work they now perform with dull monotony, it must, I consider, prove an advantage to us if the workman is able to bring intelligence to bear upon his daily toil. The report of The Gas Institute Committee, which we look forward to, will probably indicate how far we can or should go in this matter, whether as regards gas manufacture they agree with what has been uttered by Mr. Lewis T. Wright, of Nottingham, that "the fountains of knowledge need no jealous guard lest the crowd should drink too freely of their springs; millions can never drink them dry, because their sources are too infinite to ever fail."*

Going on now to the unsavoury subject of commissions, I must say I have been scarcely able to believe my own eyes as to what has appeared in the last number [Feb. 14] of the *Journal of Gas Lighting* under the head of "The Reform in Progress," as well as in the "Correspondence" columns. For the honour of the profession, I do sincerely hope that the Editor has been led to write as he has upon the subject under a misapprehension of the facts; for I am indeed very loth to depart from the view I felt justified in taking up in my last address to you when referring to the lamentable Salford case. I am unable to bring myself to believe that there

* See address to the Nottingham Section of the Society of Chemical Industry, *Journal of Gas Lighting*, Vol. L., p. 968.

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are sufficient grounds for the very grave statements which have recently been published in the *Journal*, which we are all accustomed to look to to support and further our true interests. The more serious of them I had at first thought of repeating to you; but as the whole articles are probably quite fresh in your memories, I will refrain from being an additional medium of promulgating such serious, sweeping, and I must say unproved charges. If true, how could we as a body have been so much aroused and indignant at the Salford disclosures; it was not surely a mere act of hypocrisy, this wholesale denouncement of Samuel Hunter? I believe I am only doing you, as well as myself, justice in saying that the indignation was as sincere as the case was exceptional. Be this as it may, there can be no doubt that it is the duty of every one of us to assist as much as we can in the movement already on foot to clear the horizon from the heavy clouds of suspicion with which these allegations have covered it.

As regards the traders who are supposed to have communicated their experiences, I think they take a very low stand when they attempt to excuse themselves of the act of bribery under the plea of "custom." If the custom, which they truly say "degrades and corrupts them as well as the recipients of the blackmail," existed, as honourable men, it was their duty to have declined to follow, but expose it as soon as they each became aware of it. Laudable as it is in respect to the future, the advertisement which has recently appeared is not only tantamount to an open confession that the firms whose names appear therein have given bribes in the past, and should therefore be chastened for their conduct; but unfortunately its appearance may, in the eyes of the public, be interpreted as a reproach upon gas managers generally. I am sure, however, that we all sincerely welcome this tardy summing up of courage.

I must now say a word in favour of the colliery-owners and the traders generally with whom a gas manager comes in contact. "Speak of a man as you find him" is a wise and healthy maxim; and in support of the belief which I have hitherto held respecting the extent of "bribery," otherwise called in polite phrase "commissions," I wish to state that during my connection with the Birmingham works, extending now to over sixteen years, out of the very numerous firms with whom we have in that period had any dealings, I have only been approached by this "commission serpent" twice. I can remember both instances well—the first was about ten, the last about three years ago; the former in the shape of a Birmingham, and the latter a Lancashire firm. I hope it is superfluous to add that in each of these isolated cases I did not partake of the proffered apple, and that the tempter went off to all

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appearances abashed, and, as it were, hanging his tail behind him; and this experience is similar, although longer than that which has been published by the Secretary of the Birmingham Gas Department.* "Legislation," and others who are naturally anxious to ward off anything that shall tend to weaken the position they have thought fit to take up, may venture to offer the same explanation as they did in his case, which cannot, however, be accepted without believing that there existed a "Commission League," all the members of which were at once acquainted with the result of any fresh venture; and if this were so, how came it that the second attempt was made? No, "Legislation's" theory is untenable; and we must fall back on the more charitable aspect of the case, that the traders as a whole are not so black as some would paint them.

When alluding to the Salford scandal case last year, little did I contemplate that before our next annual meeting took place, it would have fallen to the lot of one who has been so closely connected with me for over fifteen years, to succeed to the post vacated under such ignominious circumstances by the late occupant; and while, without doubting the ability of others among the gentlemen who were competitors for the office, I am pleased to think that the Salford Gas Committee have made a wise choice, and that Mr. Shoubridge will prove worthy of their confidence. Sure I am that the honour and dignity of the profession to which he belongs, so far as he and Salford are concerned, are, without the recent advertisements, safe in his keeping; and that in no great length of time he will have removed the stigma which the recent events there cast upon our calling, and will have proved that, although there are "black sheep" in every fold, it is unjust to brand the entire profession with distrust, and notwithstanding the allurements which may surround them, gas-works officials generally come second to none in their appreciation of integrity and honesty of purpose. I cannot, however, refrain from reiterating that gas committees and directors have their duty to perform in connection with this question. They should not, as is too frequently the case (and as I venture to think the Salford Committee, in spite of their past sad experience, have done, judging from the salary they have fixed for their new Engineer and Manager), under-estimate upright conduct and the ability and responsibility of their advisers; but should in case of default take care that it cannot be said with any degree of truth that, through their parsimony in the matter of remuneration, they contributed in any way to the temptation resulting in the fall, and determine that if as time goes on greater

* See *Journal of Gas Lighting* for Jan. 24, 1888, p. 153. The letters by "Legislation" appeared in the issues for Jan. 17 and 31, 1888.

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competition for the few chief offices at disposal is brought about by means of free schools and cheap "technical education," they will still properly recognize the vast trust which must necessarily be confided to the keeping of the men who secure them—that, although, as now the weakest will still continue to go to the wall, they will, so far as they are concerned, take care that they, who after much study and hard work, have "scaled the new heights" and obtained possession, shall be duly and amply rewarded for their pains. Such, regardless of any silly outside cry, must be the policy of those who desire the further development and prosperity of the industry that we are all so intimately connected with.

As gas engineers and managers, we must have been deeply interested in the beautiful and wonderful display in the Chemical Section of the late Manchester Royal Jubilee Exhibition—the finest collection, I should think that has ever been brought together in one building. Little did Murdoch imagine that, in comparatively so few years, such a glorious sight would be presented to the public gaze as the product of that black diamond, coal. It is pardonable in any one of us to feel proud that in our daily operations we produce "the spring from which such goodness flows." Although my time was short, and the attractions of the Picture Gallery very great, I could not leave without gazing for a second time upon the numerous cases enclosing such richness of colour in so great variety. Well-earned, indeed, have been the honours bestowed upon such men as Dr. Perkins and Dr. Griess, whose labours have so largely contributed to the discoveries resulting in these beautiful colours and the other valuable properties of the "black mystery." It is a misfortune that such a collection could not have been kept together as a Jubilee memorial of the progress made in the important industries represented by them. The "Genealogical Tar Tree," upon which can be counted more than 400 different products and sub-products, presents the uninitiated with an idea of the remarkable extent to which these industries have grown, and how largely gas manufacture has contributed, in addition to the inestimable blessing of good light, the varying and numerous wants of this progressive age.

The year has opened well for us. Trade generally shows, I think (by the Railway Companies' and Board of Trade returns), distinct signs of improvement. Coke and the other residual products are realizing slightly better prices; and the predicted great fall in the value of benzol has not taken place. And, although the early part of January was marked by unprecedented mild weather, causing a general decrease in the consumption of gas, it was followed by a long spell of (from our point of view) splendid fogs, which, although not

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as advantageous as they would have been had they appeared at their usual time before Christmas, will probably be found to have compensated for the absence of severe frosts. In view of the opinions formed by competent authorities upon the recent utterances of those in high places respecting the peace of Europe, I think, upon the whole, we may venture to look forward to a prosperous year; and so be it.

Alteration of a Rule.

Mr. Simpson then moved that Rule 8 be altered, and that, instead of binding the Association to hold four meetings a year, it should provide that meetings should be held in the months of February, May, and October only.

Mr. North seconded the motion, and it was carried.

The Automatic Gas-Meter.

Mr. R. W. Brownhills, of Birmingham, exhibited and explained the automatic gas-meter which he has devised. The object is to facilitate the supply of gas to the poorer class of consumers by enabling them to pay for it as they use it. They can put a penny, or a number of pence, into the meter, and gas to an equivalent value will pass through for consumption. The collector finds in a box on the meter the money for the gas burnt. The meter exhibited was devised on an assumed price of 2s. 6d. per 1000 cubic feet.

Mr. J. West (Manchester) asked what would be done if the price were lowered?

Mr. Brownhills said there would be no difficulty about that. A discount could be allowed on the money deposited in the meter. In reply to questions by different members, he said they might put in varying numbers of pence, and the dial would indicate what money had been deposited. It would be possible to insert pieces of lead or iron; but as the meter would be in the care of the occupant of the house using the gas, they would know who had put such things in. They had already brought the price of the meters down to one guinea each; and the number it was hoped would be required would further reduce the cost.

The President moved a vote of thanks to Mr. Brownhills for exhibiting his meter and for his explanations; remarking that it was an invention which he believed would prove beneficial to small gas consumers.

Mr. Tindall seconded the motion, and it was carried.

Mr. Brownhills acknowledged the compliment.

The Payment of Commission to Gas Managers.

Mr. Ellery then moved a vote of thanks to the President for his address. He was glad the President had referred to a subject

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which had lately been made prominent. Although there might be dirt in some waters, the reflections made on the majority in their profession were uncalled for. He did not know whether attention was not being drawn in the wrong direction, when one saw letters from manufacturers and others who posed as having nothing to do with commissions, who were willing to sign declarations of innocence, and yet soiled their fingers with bribes, saying or implying it was only with bribes they thought they could transact business. It was wise to hesitate before taking steps which might lead in the direction of inducing men to lie as well as to be dishonest. The acceptance of commission (which he trusted was the exception and not the rule) and the offering of commission, were things which ought to be checked. The commercial world, so far as gas was concerned, had been placed under a cloud it scarcely deserved in the matter. Concerted action or Acts of Parliament would not cure the evil that existed. This could only be done by increasing and deepening the sense of honour and rectitude in those guilty of such dealings.

Mr. A. Colson (Leicester) had much pleasure in seconding the vote of thanks to the President for his instructive address. The suggestion with regard to original investigation was a most valuable one, and worthy of consideration. He thoroughly sympathized with the President's remarks on the statements recently made in the *Journal of Gas Lighting* with reference to commissions and bribes; and he could not think it possible that grounds existed for such assertions as were made. With one exception, he had never had the question of commission brought under his notice. He was written to by a firm on the subject about four years ago; and he immediately laid the letter before his Committee, who instructed the Town Clerk to acknowledge the receipt of the offer, and to inform the firm that their name had been struck off the list of those with whom they transacted business. They had never since had dealings with that firm, and they never should. From his knowledge of gentlemen with whom they had business relations and of his brother engineers, he believed the system of commissions and bribery did not exist to nearly the extent that the writer of the articles evidently thought.

The motion having been carried,

The President briefly thanked the members, and the proceedings closed.

Visit to Messrs. Piggott and Co.'s Works.

After the meeting the members visited the works of Messrs. Thomas Piggott and Co., and witnessed their patented process of welding large wrought-iron tubes by means of gas.

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MANCHESTER INSTITUTION.

ANNUAL MEETING, MARCH 3.

This Meeting was held at the Victoria Hotel, Manchester—Mr. T. Moore, of Macclesfield (the President), in the chair.

The Honorary Secretary (Mr. W. W. Hutchinson, of Barnsley) read the minutes of the previous meeting, and they were confirmed without comment.

New Member.

On the nomination of Mr. C. E. Jones (Chesterfield), seconded by Mr. George Smedley (Buxton), Mr. Thomas Forrett, Manager of the Alfreton (Derbyshire) Gas-Works, was unanimously elected a member of the Institution.

Annual Report.

The Honorary Secretary read the annual report of the Committee, as follows:—

The Committee are pleased to say that they can once more congratulate the members upon the continued usefulness and prosperity of the Institution.

There have been nine new members elected during the year. The Committee regret that one member—Mr. Frederick Bower of North Bierley, Oakenshaw—has been removed by death, and will be much missed by those who knew his sterling qualities. Three members cease membership under Rules Nos. 1 and 17 (leaving on the roll, 90); and should the gentleman submitted to-day be elected, it will make a total of 91.

The opening meeting of the year was particularly well attended, when the President (Mr. T. Moore) gave a well-considered and exhaustive inaugural address. The May meeting was held at Chester, after which (under the guidance of Mr. F. W. Stevenson, the Engineer of the Chester Gas-Works) several places of interest were visited—including Eaton Hall, the seat of the Duke of Westminster. Your Committee considered it was advisable to take advantage of the opportunity offered by the Royal Jubilee Exhibition being held at Manchester (with its unrivalled Chemical Section); and the August meeting was therefore held in the Prince's Reception Rooms, when Dr. Watson Smith, F.C.S., F.I.C., &c., the Vice-Chairman of the Chemical Section, gave a descriptive lecture upon the various products exhibited in connection with the gas industry. After unavoidable delay, the discussion upon Mr. Duxbury's paper, on "Coal Liming," took place in December; and this question was thoroughly debated. Mr. James Dalgliesh read an excellent statistical paper upon

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"Oil and Other Illuminants and their Effect on the Consumption of Gas," the discussion of which comes before you to-day.

By consent of the members, an addition to Rule No. 4 has been made.

All the meetings have been well attended; and the members generally evince the most careful interest in the proceedings.

The thanks of the Committee are due to the various members who have so ably supported the Institution, by reading papers and in other capacities—thereby rendering excellent services in promoting knowledge in the profession generally, which cannot fail to forward the welfare of the gas industry.

The retiring members of the Committee are Messrs. W. R. Chester and J. Dalgliesh, who are eligible, under Rule No. 4 for re-election.

The financial condition of the Institution is fully shown by the accounts now submitted; the amount of subscriptions in arrear being very small.

It will be in the recollection of the members that several lectures were given some years ago, under the auspices of the Institution, by eminent professors on various gas questions; and the question of their reintroduction has been, and is still under the consideration of the Committee.

(Signed) THOS. MOORE, President.
W. W. HUTCHINSON, Hon. Sec.

The PRESIDENT moved the adoption of the report and balance-sheet.

Mr. R. HUNTER (Stalybridge) seconded the motion.

Mr. W. WOODWARD (Bury) asked if the sum of ten guineas, mentioned in the accounts, was the fee paid for Professor Watson Smith's lecture delivered at the meeting of the Institution held in August last.

The PRESIDENT said it was.

Mr. J. CHEW (Blackpool) wished to know whether the scheme which the Committee were considering meant that they were to have more lectures of a similar kind, and at a like expense. If so, his opinion was that the money would be better spent in organizing a series of experiments by various gas engineers, who should report the results to a Central Committee, as was done some years ago by The Gas Institute, with very advantageous results.

The PRESIDENT explained that Mr. Watson Smith's lecture was an exceptional matter. That gentleman practically had charge of the interesting Chemical Section of the late Manchester Exhibition; and he not only gave them the lecture in the Prince's Reception Room, but spent the day with them in the Section. What the Committee were now considering was the propriety of going back to a custom which they had some years ago, of inviting eminent men to give them lectures on matters connected with the production of gas. Sometimes there was a difficulty in obtaining papers; and all matters of engineering importance were so immediately thrashed out that it had suggested itself to the Committee

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that it would be advisable to obtain the assistance of the most eminent men of the day to deliver addresses on the more recondite subjects connected with the gas industry. As yet, the Committee had not arrived at any definite conclusion.

Mr. CHEW said he was not finding fault with the expenditure or the lecture. But the President would remember that some years ago the Institution tabulated the results of some experiments on retort firing; and The Gas Institute, with the assistance of Mr. Greville Williams, F.R.S., and another gentleman, published a report on the proper condensation of gas. These added considerably to the information of gas managers. As papers were not forthcoming so freely as the Committee would like, he thought it would be as well to resort to the old plan, and to tabulate information on purification, carbonization, condensation, or anything else they pleased. By doing this, they might bring about better methods of working in some instances.

The report and balance-sheet were then adopted.

ELECTION OF OFFICERS.

Mr. W. R. CHESTER (Manchester) proposed the election of Mr. T. Banbury Ball, of Rochdale, as senior Vice-President of the Institution for the ensuing year.

Mr. T. O. PATERSON (Birkenhead) seconded the motion, and it was unanimously agreed to.

Mr. BALL, in acknowledging the resolution, said he would do what he could to justify the cordial approval with which his name was received.

Mr. T. NEWBIGGING (Manchester) proposed that Mr. W. W. Hutchinson, of Barnsley, be elected junior Vice-President. He said that during the past four or five years Mr. Hutchinson had discharged the duties of Honorary Secretary with great assiduity and conspicuous ability; and he hoped that he would consider his election to the office of Vice-President a reward in some sense for what he had done for the Institution.

Mr. J. DALGLIESH (Glossop) seconded the proposition.

The PRESIDENT having testified to the interest which Mr. Hutchinson had always manifested in the Institution,

The resolution was carried by acclamation.

Mr. HUTCHINSON, in reply, said he hoped that, as time went on, the members would find their choice of him for this office fully justified.

Mr. HARRISON VEEVERS (Dukinfield) proposed, and Mr. HUTCHINSON seconded, the re-election of Mr. T. Newbigging (Manchester) as Treasurer.

The resolution was carried.

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Mr. NEWBIGGING said he thanked the members for the unanimous vote they had passed. Most of them knew that the office of Treasurer was honorary not only in name, but in reality. The Treasurer of the Institution had not much money in his hands at any time; and it was not necessary that he should have. All the same, however, he esteemed it a high honour to fill the post; and he thanked them for this further token of their confidence. He considered it an honour to be connected with the Institution, notwithstanding the obloquy which had been cast on the gas interest in recent times. His experience of the gas managers of Lancashire and Yorkshire and the adjacent counties who were members of the Institution—and he did not limit his remarks to them, for he had an equal experience of those farther north and farther south—but he was speaking particularly at present of those connected with the Manchester District Institution; and his experience of them was that they were, as a general rule, an honourable and straightforward body of men. It did not follow because there were some black sheep, that there should be a general condemnation. It was ungenerous and unfair that a whole class should be placed under the ban of suspicion for the delinquencies of a few; and he protested against it. He believed that some of those who were now loud in their condemnation of the abominable commission system had in the past done their share in trying to corrupt the men with whom they had dealings. He had no hesitation in saying that, taken as a body, the gas managers of this country were both able and honest. Their ability was conspicuous in their conduct of an important industry, which, while almost every other industry had flagged of recent years, had been uniformly successful, even though labouring under many disadvantages.

The PRESIDENT said they now approached a very important part of their proceedings—the election of a Secretary; and he would ask Mr. Hutchinson, who was determined to retire from the office, to propose his successor.

Mr. HUTCHINSON said that he readily responded to the call, because he had every confidence in the gentleman whom he would submit as his successor—viz., Mr. Harrison Veevers, of Dukinfield—who had such ability and knowledge as would enable him to discharge the duties of the office thoroughly.

Mr. G. SMEDLEY (Buxton) seconded the proposition, and it was carried unanimously.

Mr. VEEVERS said he accepted the office with a great amount of diffidence—not from any want of interest in the Institution, but because, since he promised to undertake it, there had been placed upon him the extra work of Surveyor and Manager of the Dukinfield Water Department. However, with the assistance of his son,

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he should perhaps be able to discharge the duties of Secretary during the next twelve months.

Mr. J. CHADWICK (Oldham) said he was pleased to be present that day to be the medium of submitting the next resolution, which was a vote of thanks to Mr. W. W. Hutchinson for his services as Honorary Secretary during the past four years.

Mr. CHEW, in seconding the motion, remarked that Mr. Hutchinson had contributed several eminently scientific papers to their proceedings; and he particularly remembered one, from which he (Mr. Chew) derived much information, on "Sulphur Impurities in Coal Gas,"* which was read at a meeting of the Institution at Barnsley.

Mr. R. HUNTER said, as a former Secretary, he had great pleasure in supporting the resolution.

The PRESIDENT expressed his full agreement with all the praise bestowed on Mr. Hutchinson.

The resolution was heartily carried.

Mr. HUTCHINSON, in acknowledging the compliment, said it had at all times given him pleasure to do what he had done for the Institution.

The PRESIDENT observed that the altered rule gave them power to re-elect a member of Committee, who had filled a short term of office in supplying a casual vacancy; and he proposed the re-appointment of Mr. W. R. Chester for the next three years.

Mr. WOODWARD seconded the resolution, which was carried.

Mr. BALL proposed the re-election of Mr. J. Dalgliesh, who had also, like Mr. Chester, served a short time, and shown great capacity for the office.

Mr. ISAAC CARR (Widnes) seconded the resolution, which was cordially supported by Mr. SMEDLEY; both gentlemen referring to Mr. Dalgliesh in complimentary terms.

The resolution was adopted.

THE NEW PRESIDENT.

Mr. MOORE said he had now to make his bow as their President, and retire in favour of his successor—Mr. Duxbury. He thanked them for the courtesy they had accorded him, and the support given him at all times.

Mr. T. Duxbury (Darwen), the President-Elect, then took the chair.

THANKS TO THE LATE PRESIDENT.

The PRESIDENT, rising immediately after taking the chair, moved a resolution thanking Mr. Moore very cordially for his services.

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* See *Journal of Gas Lighting*, Vol. XXXIV., p. 399.

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Mr. VEEVERS seconded the motion, and it was carried with applause.

Mr. MOORE having briefly acknowledged the compliment,

The PRESIDENT delivered the following

INAUGURAL ADDRESS.

Gentlemen,—In addressing you as your President, my first duty will be to thank you for the very high honour you have conferred upon me. Being a comparatively young member, and having in the past done so little for the Institution, I feel that this high compliment is due to the courtesy of many of my fellow-members whose services for the society would enable them to fill such a post as this with more credit to the Institution than is possible for me. While thanking you for my election to this honourable position, I shall endeavour, to the best of my ability, to fulfil the duties and obligations which attach to the office. I confess I do not feel the duties which you have imposed upon me so very light as they seemed to be when they rested upon the strong shoulders of those who have preceded me in this office. I venture, therefore, to bespeak your kindly assistance and co-operation, in order that these meetings may be as successful as they have been in the past; and I do not doubt that these will be fully accorded to me.

It is a difficult task, at this time of day, to find sufficient new matter to make a presidential address as interesting and instructive as I could wish it to be, and as you have a right to expect. The work of reviewing is now so very ably conducted by the technical journals connected with our profession—there are so many minds at work in every department, and every new idea is so elaborately dealt with in these publications—that I have found it almost hopeless to bring before you any subject that has not already been fully treated. There are, however, many theories and suggestions regarding our profession which, I think, may be reviewed afresh from the standpoint of experience; and I believe great advantages have thus accrued to the profession generally, and to our members and their employers in particular, by our meeting in this manner four times a year, and discussing our varied experience. Our Institution, consisting as it does solely of gas managers and consulting gas engineers, does not exist for the private ends of our profession, or in any way as a trades-union, but has a purely scientific interest in view; while these gatherings enable our members to cultivate a personal interest in one another's welfare, and add a fresh interest to the great industry which it is our honour to serve. We learn at these gatherings what our neighbour is doing in the way of supplying gas of the highest purity and illuminating power at the lowest possible price. Personally, I have to acknowledge that the benefits I have

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derived from time to time by thus meeting with my fellow-members, have enabled me to overcome many a difficulty. I feel proud to belong to a technical Institution that has rendered such signal service to the gas industry as it has been the privilege of this society to do; and I may be allowed again to express the hope that the papers and discussions during the coming session may not be inferior to those of any previous year.

This Institution, I am glad to say, continues to progress, both in numbers and usefulness, as we have heard from the Secretary's report, and still maintains the position which entitles it to rank as one of the highest District Associations in existence.

During the past year we have had in our immediate district a "World's Fair," in the Manchester Exhibition, such as was calculated to please the eye and gratify and instruct the mind. Whether this most excellent and varied collection of the world's industry and art has answered all the ends which its promoters and exhibitors had in view, may be doubted. But, from a gas manager's point of view, the excellent chemical exhibits formed objects of very great attraction and interest; and many of us saw for the first time a number of wonderful products which our scientists, with the aid of the chemical manufacturer, have been enabled to derive from the residuals produced at our various gas-works.

The industry with which we are allied may fairly claim to have more than maintained its own during the past year. Gas consumption is increasing on all hands. The price of gas stock generally has advanced, and is now more than ever looked upon as one of the soundest investments in this country.

The market for residuals may be, and is, very much below what it was a few years ago; and it is to be feared that these high prices will not again obtain. The values of these products cannot be very materially increased by anything the gas manager can do. We are dependent very much upon the energies and discoveries of chemists; and we have to thank that profession in Germany for many things done in the past. Gas tar continues to improve somewhat in value, as compared with prices in the immediate past; following naturally the improved values of products derivable therefrom. Yet there seems to be considerable anxiety as to how long the values of some of these products will be maintained; and seeing that the resources are great by which the products can be produced in quantities, it would be hazardous to predict a return to prices very much in excess of what they now are.

Ammonia may be fairly stated to have improved in value to the extent of fully £2 per ton of sulphate during the past year, notwithstanding that the production still continues to increase. At the present time something like 100,000 tons of it per annum are

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produced in the United Kingdom. The manufacture of soda ash by the ammonia-soda process is making gradual progress, though Messrs. Brunner, Mond, and Co. have not as yet found any very serious competitors in this business. This process still involves some exhaustion of ammonia; but if, as is necessary for the financial success of such manufacture, the whole of the ammonia practically is to be recovered, but slender demand will be made in that event upon our store of ammoniacal liquor, and we are not justified in anticipating much increase in that direction. An improved value of ammoniacal liquor may best be looked for in the consumption of sulphate of ammonia; and, according to statistics, this consumption is annually on the increase. As against this demand we must, however, set the continually increasing production from the various gas-works of the country, from the distillation of shale at the oil-works in Scotland, and from the various carbonizing processes which will further tend to increase the supply. The demand for ammonia in agriculture may, however, be regarded as a tolerably constant, if not even as an increasing quantity, though other nitrogenous elements have entered into serious competition with it.

Gas coke, I am sorry to say, still proves to be a great drug upon our hands; and in many works large heaps are stacked, and the prices are naturally low. A gas manager's time is generally monopolized by his other duties; and he cannot always secure such a market for that product as might be possible if there were a distinct department under him having that object in view. It is generally admitted that householders allow fully four-fifths of their coal, in the shape of smoke or unconsumed carbon, to escape by the chimney and pollute the air; and this in a civilized country. Now, coke is much cheaper than coal, burns readily and brilliantly when properly used, and does not give off any smoke, keeping the atmosphere in the house dry. Factories and workshops are under penalties for emitting smoke; and I venture to predict that similar penalties will yet be imposed on householders to compel them to be less extravagant in the use of fuel, and more cleanly and healthy. On this point the letter to *The Times* of the 5th of January last by Mr. A. E. Fletcher, Her Majesty's Chief Inspector under the Alkali, &c., Works Regulation Act, on "Town Smoke and House Warming,"* is well worth perusal; and the sooner suitable grates and stoves for burning gas coke are included in our show-rooms, amongst our exhibits of gas fires and stoves, the sooner will our coke heaps diminish, and better prices be realized and the atmosphere be purer, and all to the advantage of the

* See *Journal of Gas Lighting*, Vol. LI., p. 71.

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consumer. Our Belgian *confrères* are ahead of us in this respect, having recently held a competition, with prizes to the value of £240, for the best coke-using stoves, &c., the result of which is a report stating that, so far as warming rooms by coke is concerned, the problem has been practically solved.* Providing coke is sold at a price slightly under the value of coal, there is no reason why a very large proportion of the coke produced should not be sold to the general inhabitants of the town; and I do not see why the owners of gas-works should not cultivate this department more than is now done, acquainting the public with the advantages to which I have already referred.

Advertisement may be cheapened by using the back of gas bills, or hand bills or cards delivered by the meter inspectors; giving prices at the works and prices on delivery. If the gas-works are not conveniently situated for consumers to fetch the coke, then it should be carted to the consumers; the net cost being charged. Or, if necessary, depôts may be opened in different parts of the town, thus affording every facility to small as well as large consumers; and moreover we may even condescend to keep wheelbarrows for this purpose. Taking the coke produced at my own works, and deducting the amount now used for trade purposes in the town, it only requires that each house in the district should use 12 cwt. of coke per annum in order to keep us clear. What we require is a house trade if possible, as it is most reliable, and varies in its demand just as does our production—being lightest in summer and heaviest in winter. To me, therefore, it is evident that, if we would secure the greatest advantage for our employers, we must keep the retail trade in our own hands, and avoid the middleman. One of the difficulties met with is that houses generally have only one fuel-shed in the yard, which is already occupied with coal; but, as Mr. Somerville told us some time ago, "a mixture of two-thirds coke and one-third coal used in ordinary domestic fireplaces makes a splendid radiant fire, practically smokeless, with a saving of 30 per cent."

Reversing somewhat the order of the process of gas manufacture, I feel tempted to say a few words on the "steam-roller question," which has occupied the attention of the Law Courts during the past year. We are informed that The Gaslight and Coke Company have spent £10,000 in lawsuits in fighting the local authorities as to their right to use heavy steam-rollers for mending and making roads, and at the same time breaking gas and water mains and services to an unwarrantable and unnecessary extent. Having thus proved beyond doubt that local

* An abstract of the report here referred to appeared in the *Journal of Gas Lighting* for Jan. 17, 1888, p. 101.

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authorities have no right to use machines of such ponderous weight for this purpose, without carrying with it liability for injury done, I am persuaded that gas managers and companies generally are under great obligation to the Company for the action they have taken in this matter. It is not, however, gas and water companies only who are suffering under this head. In my own town, where the gas and water works belong to the Corporation, we possess a steam-roller weighing about 16 tons; and in one particular year a large number of the principal streets were re-made, and, of course, the roller made a nice road, with which the Borough Surveyor and the members of the Town Council were highly satisfied, and had reason to be, though the overground advantage was more than counterbalanced by an underground disadvantage, which cost the ratepayers not a little in gas and water pipes and leakages. The result of the use of the roller, however, is shown by the fact that the year after it was commenced our gas leakage was more by 4·27 per cent., or 4¼ million cubic feet, than it was the year before the roller came into operation; and we had no other disturbing element during this period to produce this result. As Manager of the water-works, I found the water-mains also suffered very considerably; and I have every reason to believe that the Gas and Water Departments of my Corporation are still suffering to the extent of some hundreds of pounds per annum from the past use of this steam-roller.

Reverting now to the manufacture of gas, I cannot say that any very great strides have been made during the past year. The ideal retort-house into which we accompanied Mr. T. Moore twelve months ago, where the coal was to be fed into the retorts automatically and continuously, has not yet been realized; but experiments have been made, and are still going on which indicate some progress in this respect, though it would be premature as yet to hazard an opinion as to its ultimate success. One of our members (Mr. W. Woodward, of Bury) has recently erected a bench containing settings of eleven retorts in each oven, as against the usual settings of seven. This, as will be seen, will give an increased producing power of (say) 50 per cent. on the same floor space and in the same house, providing it can be worked as economically, and with the same results. Though this is not new, it is an innovation in this district. Steam-boilers 40 or 45 feet long have been tried; but they are being abandoned. The general concensus of opinion seems to be that boilers 30 feet long are the most economical; and this is becoming the standard size. There is no doubt an economy-limit to the number of settings in an oven, floor space notwithstanding; and this appears to have settled generally to seven retorts. To maintain uniformly high heats with short charges, and

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thereby retain in the gas those vapours of benzene that are of so great a value for illuminating purposes, ought to be our object; otherwise these vapours will be lost to the gas, and find their way into the tar-well. We shall be pleased to hear from Mr. Woodward, in due course, the result of his working.

On the important question of condensation and the deposition of naphthalene, there is still plenty of room for experiment for any member who has the leisure and disposition at command. I have frequently found myself very much troubled with naphthalene deposits, which have mostly occurred in the consumers' service-pipes, and in a very short time have either deprived the consumers of gas altogether, or reduced the supply to a minimum. In some instances this has affected as many as 200 to 300 in one night. This has occurred mostly after a sudden change in the weather; but more particularly in the autumn from August to November, and with the first bite of frost. Formerly our trouble in this respect occurred in the street lamps, and was generally found in the check-tap near the top of the pillar. But since removing the check-tap close to the burner inside the lantern, where it is kept warm, our difficulties with street lamps have very much diminished. I am not troubled in the works or mains.

Observations of the temperature of the gas at the various parts of the works are recorded every three hours. I have endeavoured to vary some of these temperatures as far as my insufficient apparatus would allow; but up to the present I have not succeeded in finding any antidote for this evil. It seems to come and go mysteriously; acting so erratically that we are unable to predict the immediate signs either of its approach or disappearance. If the heavy tar is allowed to effect its removal, a deleterious action on the illuminating power of the gas is the result; and if condensation is to be relied upon, there is the danger of condensing the hydrocarbons that are subject to liquefaction at low temperatures. There is no doubt that the length of the charges and the heats at which we carbonize have something to do with its formation; and if any of our members are able and willing to throw further light upon the subject, they will help many of their friends, myself amongst the number.

The purification of gas is a subject upon which more has been said and written than perhaps any other branch of our profession; and many men with varying minds have been working in different directions to accomplish the same object. The report just published by Mr. Valon, on purification by means of oxygen,* is an addition to our store of practical knowledge on this subject. In

* See *Journal of Gas Lighting*, Vol. LI., p. 330.

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purifying, however, there is very little margin left to work upon, and any new process must not cost substantially more than it does at present; for though consumers will call urgently for pure gas and no nuisance at the works, still their language would be equally forcible in objecting to pay even 1d. per 1000 cubic feet more in order to attain these ends. So long, however, as we use solid materials for purification, so long shall we have, in a greater or less degree, the expense and nuisance of emptying and recharging purifiers. It must be admitted, however, that, notwithstanding all the processes of purification that have been patented from time to time—embracing copper, lead, zinc, manganese, iron, barium, magnesia, &c., and the acids (nitric, sulphuric, and muriatic), including compounds of potash and soda—our boasted progress in this respect is but slow. To remove at one operation the impurities that are injurious to health and deleterious to the illuminating power of gas would be a great boon both to makers and consumers; and although such processes as those of Claus, Young, and others, are receiving considerable attention, it seems that the means employed are both complicated, cumbersome, and expensive, and though they may perhaps be more scientific than the present methods, still it would appear that, in any case our systems adopted to remove a "bit of impurity" involve costly structures, clumsy plant, and a consequent heavy outlay of capital, very much on the principal of employing an elephant to push a perambulator.

To remove carbonic acid from coal gas has been the aim and object of many gas managers; lime being used for this purpose, and the oxide being allowed to remove the sulphuretted hydrogen. It is asserted, however, that carbonic acid does not exert any deleterious or injurious effects, and that its existence in coal gas is not harmful except as a diluent, being useless for heating or illumination. If this is strictly correct, then the desirability of its removal by our present methods would seem somewhat problematical. I have made a number of tests of gas containing considerable quantities of this impurity, and again after their removal (or nearly so), and I am not prepared to state that any gain in illuminating power has been the result. True, there ought to be such a gain; and I can only account for it on the ground that lime, in abstracting carbonic acid, also absorbs other illuminating matter—thereby nullifying the effects of the removal of carbonic acid. We have heard during the past year about Weldon mud,* for which the experimentalists claim that it will remove carbonic acid, sulphuretted hydrogen, and bisulphide of carbon at one operation; becoming charged with 80

* See reference to this subject, *ante*, p. 10.

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to 90 per cent. of recoverable sulphur, and this without any additional capital. If this can be accomplished, whether in the dry or the liquid state, without deteriorating the illuminating power and without nuisance, it is a step in the right direction, and will give some advantages to gas-works conveniently situated for obtaining the material.

In dealing for a short time with our greatest competitors—oil and electricity—I have no desire to forestall in any manner the discussion which is on our *agenda* to-day on Mr. Dalgliesh's excellent paper read three months ago.* As Mr. Dalgliesh stated, Scottish shale-oil works have suffered severely during the past year by the enormous importation of cheap petroleum; and the large production from Russia has, no doubt, been an important factor in producing this fall in prices. A combination has also been formed in America for restricting the output for the current year by one-half; but this will only produce an artificial effect. Competition is said to be the life and soul of commerce; but I must confess that Mr. Dalgliesh's figures are rather startling. Oil competition needs no Act of Parliament, like gas and electricity; but is unhampered by duty and restrictions. The chief cause of its popularity is doubtless its cheapness, which is the result of its abundance. Although this democratic competitor is not so brilliant as its aristocratic rival, electricity, it is proving itself to be the more formidable of the two.

In order to cope successfully with these competitors, gas must be popularized, restrictions removed, and prices reduced as low as is compatible with solvency. Then, to popularize gas in every way ought to be our aim. The unpopularity of gas is probably increased by the fact that gas producers have now a monopoly; and to many a monopoly is sure to excite suspicion, and squares with their ordinary notions that sooner or later they will be victimized. This idea must be dispelled; and like the butcher and the baker, we must endeavour to show our customers that we are prepared to meet their wants and conveniences, and even humour their whims, until they see that the terms "monopoly" and "liberality" are in this case synonymous.

Gas must be sold cheaply; and the time is not far distant when gas consumers alone shall have the benefit of gas profits, instead of the non-consumers, as now in many towns, sharing a profit which they have not helped to produce. Its cleanliness and adaptability for all purposes are such as to enable us, under fair conditions, to out-distance every competitor, if we can only secure its widespread use. Reductions in price with us are not made

* See "Reports of Gas Associations" for 1887, p. 816.

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prospectively, but when visible returns have been secured, and not before. The policy, however, of dealing with this matter in a bolder manner commends itself to my mind—viz., ascertaining what we can produce gas for at our respective works under favourable conditions, and then offering it to the public at so cheap a rate as will drive competition out of the field.

With respect to the removal of restrictions, I may say that, at the beginning of this year, my Committee decided (1) to dispense with deposits; (2) to keep all ordinary service-pipes from the main to the meter in repair free; and (3) to fix hired meters without cost to the consumers, still charging a small sum for meter-hire. The effect has been that from Jan. 13 to Feb. 25, 969 consumers have applied for and received back their previously-paid deposits, amounting to £289 10s.; 112 persons who were not consuming gas have had their own meters coupled; 12 have had hired meters fixed; and 33 have their meters undergoing repairs, necessitated through standing idle so long. So that in the 43 days above mentioned, 157 consumers have been added to our rental, as the result of this action. To enable us to carry the principle further if possible, we have made a house-to-house visit of all our non-consumers of gas, with a view to ascertain why gas is not being used; and I have endeavoured, as far as possible, to record the actual reasons given by each, which accounts for some of the answers being very much, but not quite alike. I give them, in the following list, exactly as we obtained them :—

1. 89 have no objection to use gas now that deposits are dispensed with, and are in fact prepared to take gas.
2. 243 object to pay deposits.
3. 11 object to pay meter-rent.
4. 271 cases where the fittings inside the house are out of order.
5. 16 „ „ „ are inconvenient, out of the way.
6. 20 have no fittings in the house.
7. 48 have no meter in, or meter is out of order, and property-owner declines to remedy this.
8. 5 have outside service-pipe out of order.
9. 10 cases where owners will not fix service-pipes and meters.
10. 120 previously were consumers; but, bills being too heavy, they gave up using gas. In most of these cases dilapidated fittings are the cause.
11. 301 can pay for oil weekly, but cannot afford to pay a gas bill at the quarter's end, when it comes in a lump.
12. 134 cannot afford to use gas—too dear or too expensive.
13. 306 think oil is cheaper than gas.
14. 90 prefer oil, without giving any other reason.
15. 50 prefer oil, because it is cheaper than gas.
16. 66 prefer oil; they always had oil, and never used gas.
17. 95 have never used gas.

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18. 41 are not settled in their present houses, and are contemplating removing.
19. 10 say gas is poor—poor quality, or bad gas.
20. 7 say gas is too dear and bad.
21. 6 say gas is too dear for the quality.
22. 6 say gas is injurious to health.
23. 22 say gas spoils window plants.
24. 17 will not give any reason at all.
25. 35 give various reasons—such as: Meter went too fast; think they have been cheated; unjustly summoned; bills were larger after meter was changed; been imposed upon; lodgers might burn it all night; go to bed at dark; had some bother once with the inspector; &c.

Nos. 1, 2, 8, and 9 will be immediately looked after; and Nos. 4, 5, 10, and a very large proportion of Nos. 12 and 13 are directly due to bad fittings, and leakages occurring in many cases, causing a meter registration out of all proportion to the gas actually used; the result being an order to "shut off the gas." No. 11, and I believe a large portion of Nos. 14, 15, and 16, are 500 people who represent a class that can pay from 3d. to 8d. per week for oil if paid weekly; but who, from improvidence or some other cause, are unable to keep the money until the quarter's end, and pay a gas bill. I need hardly say that we have many cottagers who are not paying as much for gas as oil burners are for oil. We shall be glad to have, on an early date, the experience of some of our members who are making weekly collections for gas; and if the automatic gas-meter, into which a man may put his penny, and then use his pennyworth of gas, proves a success, and can be supplied at a reasonable price, it may have a good future before it for this class of customers.

One great difficulty I have to contend with is the fact that nine-tenths of the gas-meters are owned by the property-owners or tenants; so that if a consumer ceases to burn gas, the meter is not brought out as is the case with hired meters, but is left coupled up. I find that this ownership of gas-meters hampers us considerably in keeping down complaints and satisfying the consumers; for many people think that, like Tennyson's brook, a gas-meter (and gas burners and fittings as well, for that matter) should "go on for ever." Vain attempts are made to show people that a periodical overhauling of the meters is necessary; and frequently we are told that the meter has gone on for 10, 15, or even 20 years without ever being examined, tested, or repaired, and the consumers see no reason why it should then be done—it being broadly hinted "that the gas bills are not big enough for us." I find also a further difficulty arising from the fact that in very many cases a one or two light meter is made to do duty for a five

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or ten light meter; and we might as well "whistle jigs" as endeavour to dissuade some people from the notion that larger meters and larger gas bills are synonymous terms. Let those managers who have nearly all hired meters, and can thus remove one and fix another without let or hindrance, be thankful for their position.

Turning now to that favoured child of fortune, our aristocratic rival the electric light, we find that, notwithstanding that it is receiving all the care and support that science and scientific influence can bestow upon it, and that the public have a predisposition to welcome and patronize anything in the shape of a rival to gas, it has failed to accomplish much that was predicted. The effect of puffing the electric light has been the cause of delay in making extensions at my own gas-works, and no doubt elsewhere throughout the country; resulting in considerable loss, besides the anxiety and risks we have run. The Corporation I represent had power in their Act of 1879 to spend £5000 upon an electric light installation; but up to now, the only item of expenditure is the sum of £317 taken from the gas profits, which sum was incurred in visiting towns partly lit by electricity and in consulting electrical engineers. The installation at Taunton seems to have been anything but a success; for Alderman Burford tells us, "that at present the ratepayers of Taunton are paying an extra sum, more than equal to a 2d. rate upon the whole borough for the advantage of the electric light in about one-quarter of the district;" and Mr. Edwards informs us, "that this installation has replaced gas-lights to the extent of a consumption of about 500,000 cubic feet of gas per annum at a cost of £80, and, so far as can be at present ascertained, the Electric Light Company are receiving about £1100 for doing this."

In my town there are several installations of the electric light; one being at a gentleman's residence. While this gentleman feels persuaded that the electric light is costing him more than gas would, he places his savings in the avoidance of injury to decorations, curtains, pictures, books, &c., at at least £100 per annum. Taking the quarter ending December, 1887, as a basis, the gentleman alluded to argues that 30 gas-burners, averaging four hours' consumption daily, burnt 69,000 cubic feet of gas, costing £11 4s. 3d., and that for 40 incandescent electric lights burning for a period of eight hours daily, his gas-engine used 82,100 cubic feet of gas, costing him £13 6s. 10d.—obtaining only 10,920 burner-hours in the first instance, as against 29,120 lamp-hours in the latter. From our own books and the gentleman's statements to me, however, I beg to submit that the following method of arriving at the cost is a perfectly fair one.

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Cost of plant			£450 0 0
Interest (5 per cent.) and depreciation (10 per cent.)			£67 10 0
100 lamps per year, at 4s. each			20 0 0
Oil, waste, and sundry items of repair (estimated)			5 0 0
(The gardener attends to the engine, dynamo, &c., for which no extra is paid.)			
	Gas still used in the House. Cubic Feet.	Gas-Engine. Cubic Feet.	
1885	142,200 ..	193,000	
1886	122,100 ..	125,900	
1887	131,700 ..	168,700	
Total for three years	396,000 ..	487,600	
Average	132,000 ..	162,500	
132,000 + 162,500 = 294,500, at 3s. 3d. per 1000 cubic feet			47 17 0
Total cost of the electric light			£140 7 0
The total cost for gas previous to the installation of the electric light was—			
	Cubic Feet.		
1880	231,900		
1881	225,700		
1882	196,600		
1883	234,900		
Total for four years.	889,100		
Average	222,330, at 3s. 3d. per 1000 cubic feet . .		36 2 6
Extra annual cost of electric lighting			£104 4 6

The above statement shows that this gentleman backs his opinions by practice, as he stated his preference for the light, though it might cost him four times more than gas. It must not, however, be taken for granted that electric light cannot compete with us under any circumstances, as I have reason to believe that it can. There are four paper-mills in my immediate neighbourhood now using electric light; and the following are the results given by the proprietors so far as annual gas consumption is concerned:—

	1	2	3	4	Totals.
Amount formerly paid for gas . .	£439	£109	£318	£522	£1388
„ now paid for gas	—	—	28	131	159
Diminished gas consumption. . .	£439	£109	£290	£391	£1229

In these cases it must be remembered that paper-mills are lit up for about 3000 hours per annum.

In giving the figures, showing how largely oil and electricity are competing with my own works, I do not wish to indicate that we

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are retrograding, or even standing still. Our consumption continues to increase; and this year we are spending £35,000 in extending our works. This will enable us to meet the increased demand, at a diminished cost of production; and to improve the quality.

The question of following the gas we supply to the point of combustion is one that is deserving of more attention from purveyors of gas than it now obtains. Electric light companies carry their system direct to the lamp; water companies are allowed to make rules to regulate the size and strength of pipes, and the quality of workmanship; and in both cases the advantages to the consumers and companies are mutual. At present gas consumers are not protected from their own ignorance in this respect; and consequently receive less value for their money—do not get sufficient light from the gas they use—and, as a result, dissatisfaction exists, and the extension of gas consumption is retarded. I have no hesitation in believing that in my own town we should have 700 more gas consumers to-day if the fittings had been under proper regulation; while the complaints of deficient illuminating power arising from the same cause may be counted by as many more. Gas-fitters, as a rule, are not guided by the principles which regulate the flow of gas through pipes at minimum pressures, but, according to their experience, invariably make a guess, or act on a rule-of-thumb process; and as builders generally are prepared to pay as little as possible, the cheap and showy fittings of a flimsy character, and the smallest sizes of pipes, are generally adopted. Then, when the supply of gas is not sufficient with an ordinary-sized burner, a larger burner is procured, which, being out of all proportion to the gas being supplied to it, makes matters worse. The gas is burnt to waste, ceilings are blackened, the atmosphere polluted, and a dim, smoky, flickering light is the result; after which the consumer, having done his best, showers the usual blessings on the gas-works and its manager.

I would also draw your attention to the dangerous character of the water-slide chandelier. Unfortunately, there is a horrible record of paraffin-lamp explosions, setting fire to property and persons; the number of deaths from this cause being appalling. But are we, as gas managers, not open to the same taunt, though in a less degree? I have no hesitation in thinking that a very large proportion of the gas explosions we hear of are the result of the use of water-slide pendants; and, in my opinion, these ought to be condemned by every gas manager. We are fighting paraffin and electricity, and we ought to preclude the possibility of our opponents turning round and challenging us on the ground of safety.

The recuperative lamps of Wenham, Siemens, and Bower, and

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the incandescent lamps of Clamond, Welsbach, and others, are beautiful samples of what can be done in the way of burning gas scientifically. Still, durability and price are elements to be taken into consideration; and it is somewhat significant to hear from Copenhagen (Mr. Marshall, I presume) that these lamps can be purchased from Germany at 30 to 40 per cent. less than from England.*

In the ordinary common burners, however, there is no lack of variety. But of these there are burners *and* burners; and consumers require information as to which *are* which, and how long they should last. I requested a mill-owner in my town to furnish me with four burners from his mill; and to select what he considered a bad one, a good one, and two medium ones. He did this; and, after a large number of tests, I found the average illuminating power (from 17·68-candle gas) of these four burners to be 7·06 candles, whereas a new burner (somewhat similar) yielded 12·48 candles. This man, therefore, whose gas bill was more than £100 a year, was losing 76 per cent. of light obtainable from the gas; or he might have had the same light at a correspondingly reduced cost. He told me the burners had not been changed for years; and he was what we considered a fairly intelligent man—being a J.P. and a member of the Town Council.

In conclusion, gentlemen, allow me to thank you for your attention. I make no apology for the somewhat local character of my remarks. We meet here for mutual improvement; and, in my opinion, this can best be accomplished by each member giving his own practical observations and experience. A few well-established facts counterbalance volumes of opinions; and figures showing clear and precise results of working or experiment are of more value than columns describing abstract theories.

Mr. R. Hunter said the interesting address the President had given them was full of practical suggestions; and he moved that their thanks be accorded to him for it.

Mr. J. Booth (Southport) seconded the motion.

Mr. T. B. Ball (Rochdale), as Senior Vice-President, submitted the resolution; and, in doing so, said he should like to add his own testimony to the pleasure and profit he had derived from hearing the address. There were many points in it, especially with regard to distribution, which were worthy of their best attention. Amongst them he might mention that of consumers' meters and fittings. In his own district, although the consumption did not much exceed 300 million cubic feet, they had nearly 20,000 meters. He saw a gentleman in front of him whose make of gas was in

* See letter, signed "F. D. M.," in the *Journal of Gas Lighting*, Vol. LI., p. 373.

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excess of the quantity he had named; but whose meters did not number many more than 7000. Of the 20,000 meters in Rochdale, not one belonged to the Corporation. Any attempt, therefore, on his part, to bring them under thorough inspection would produce such a hornet's nest about his ears that he was appalled at the mere thought of it. He was certain that the Corporation were losing thousands of pounds every year because it was not done; but he did not think he should be strong enough—he did not think even the Corporation would be strong enough—to insist on a thorough inspection of these meters, because the very thing that would be done would be a wholesale condemnation of the smaller ones, some of which were 20, 30, or 40 years old.

The vote of thanks was carried with applause.

The PRESIDENT, in responding, said with reference to the remarks of Mr. Ball on the subject of meters belonging to the owners of property, he knew this was a great bugbear. He had suggested to the Chairman of the Darwen Gas Committee the advisability of adopting means whereby they might all become the property of the Corporation. Some people would, no doubt, give them the meters on the condition that they kept them in repair and found new ones when requisite, without charging rent for them. This was the spirit of the suggestion he had made. It had not yet been acted upon; and whether it would be or not, he did not know. He was obliged to the members for their expression of approval of his address.

POSTPONEMENT OF DISCUSSION ON MR. DALGLIESH'S PAPER.

The next business in the *agenda* was the adjourned discussion on the paper on "Oil and other Illuminants and their Effect on the Consumption of Gas," read at the last meeting by Mr. James Dalgliesh, of Glossop. The author suggested, however, that, as there were certain inaccuracies in the table which accompanied his original paper, the discussion should be postponed. He explained that the inaccuracies arose from a hurried transcript of the figures; putting in a few cases the figures giving the consumption per mile of main into the column stating the capital of the undertakings dealt with. He added that if the discussion were adjourned, he would furnish some additional information at the subsequent meeting.

Mr. W. WOODWARD moved, and Mr. T. NEWBIGGING seconded, the postponement of the discussion; and it was agreed to.

There being no other business, the proceedings closed; and the members afterwards took tea together.

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SOUTH-WEST OF ENGLAND ASSOCIATION.

HALF-YEARLY MEETING, MARCH 13.

This Meeting was held at the Auction Mart, Trowbridge, Mr. H. SAINSBURY, Manager of the Trowbridge works of the British Gaslight Company, Limited (the President), occupying the chair. An inspection was first made of the gas-works, and then of the large modern cloth-mill belonging to Messrs. S. Salter and Sons. The usual business meeting afterwards took place.

The PRESIDENT, in opening the proceedings, alluded to the recent decease of Mr. F. C. Cockey, brother of their esteemed Past-President Mr. Henry Cockey, and member of the firm of Messrs. E. Cockey and Sons, Limited, of Frome.

A vote of condolence and sympathy with Mr. H. Cockey was unanimously passed, on the motion of the PRESIDENT, seconded by Mr. H. F. WILLEY, of Exeter.

A vote of thanks was also passed to the Directors of the British Gaslight Company, for the kind and friendly welcome extended to the Association, and for the excellent arrangements which, through Mr. Sainsbury, they had made for the comfort and enjoyment of the members.

The HONORARY SECRETARY (Mr. Norton H. Humphrys, F.C.S., Assoc. M. Inst C.E., of Salisbury) then read the notice convening the meeting, and the minutes of the last meeting, held at Exeter, were taken as read.

The PRESIDENT next proposed that the following gentlemen be elected members of the Association :—Mr. W. Budd, of Melksham ; Mr. W. H. Brinkworth, of Chippenham; and Mr. H. Gravett, of Bradford-on-Avon.

Mr. R. ASHTON (Barnstaple) seconded the proposition, and it was carried unanimously.

A proposition submitted by Mr. J. H. GRAY that the next meeting should be held at Weston-super-Mare, having been agreed to,

The PRESIDENT delivered the following

INAUGURAL ADDRESS.

Gentlemen,—In assuming the position of President of this important Association, I feel how incompetent I am to follow the

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Past-Presidents in the admirable addresses they have laid before us. I am also conscious that the Association would have been more ably served if the stern hand of Death had not removed him who, by your vote, had been chosen as President-Elect for this year. The loss of Mr. Osmond we all feel. He was one of the first members who formed this Association ten years ago; and from its commencement was a constant attendant at its meetings, and a requent contributor to the discussions. I am sure that in again referring to his death, it is with heartfelt sympathy for his bereaved wife and family; and an earnest hope that his son (who has happily been chosen by the Directors of the Dorchester Gas Company as his successor) may worthily tread in his father's footsteps. We have to deplore the death of Mr. W. H. Moody, late of Fareham, who was a regular attendant at our meetings, and always assisted in the proceedings to the best of his ability. We shall also miss to-day the presence of one who, though not a member of the Association, was often at our meetings. Mr. Frank C. Cockey for many years came into the closest contact with most of our members, as a manufacturer of gas apparatus of every description; and we all feel for our respected Past-President, Mr. Henry Cockey, in the loss he has sustained—not only of a brother, but one who had been a companion in business for so many years. Sickness too prevents the attendance of some whose places are seldom vacant. Mr. George Garnett, of Ryde, and Mr. James Lowe, of Weymouth, have both been laid aside through serious illness. We rejoice to hear of their improving health, and trust we may have their valuable counsel and help at our September meeting.

It is with great pleasure that I welcome the Association to Trowbridge, and hope that our meeting will be productive of much good to the several undertakings here represented. There is one advantage in selecting Trowbridge as a place of meeting—viz., that it is accessible in a reasonable time from all parts of our district; thus enabling a goodly number of members to attend our deliberations. I believe some of you before coming to this room have been able to inspect the only object of interest we have in Trowbridge—that is our woollen-mills, of which we are justly proud, and whose reputation for excellence of material and manufacture is world-wide; Trowbridge being the principal seat of the West of England woollen trade. I am sure that our manufacturers at the present time would be only too glad if the demand for their goods was equal to the excellence of their quality.

Our esteemed Past-President Mr. George Garnett, in his address delivered at Ryde in 1886, referred to the invention of gas lighting and its introduction into this country by William Murdoch. It may be a matter of interest to many of our members, and known to

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but few, that we have in Trowbridge a historic connection with the introduction of gas into this country, and with the erection of the first gas apparatus for lighting up the premises of Messrs. Boulton and Watt—the Soho Works, Birmingham. The late Mr. George Haden (the founder of the firm of G. N. Haden and Son, well known for their heating and ventilating appliances, whose works and chief office are in this town) was employed as a working engineer in erecting the original gas-making plant at the above named works (under the direction of Mr. Murdoch), as well as others at a later date for lighting factories in Leeds and Manchester. He also opened up negotiations, which were ultimately successful in bringing the British Gaslight Company into this town, in 1826, for the purpose of supplying the manufacturers and inhabitants with a better lighting agent than the old tallow dip.

I suppose many of you have this morning been inspecting our gas-works, and mentally making comparisons, favourably or otherwise, with those under your own care. I am sorry that there is nothing in them worthy of particular notice, as we have no special theories to illustrate, or peculiar methods of manufacture to work out; but only plain and ordinary works, producing a fair average make of gas per ton of coal carbonized, and of a moderate illuminating power, without the use of cannel to any appreciable extent. Although under no parliamentary restrictions as to the quantity of sulphur compounds allowed in our gas, and without any purifiers specially set apart for extracting them, our average analysis for the past twelve months (during which time testings for various impurities have been made, as set forth in the letter addressed to the *Journal of Gas Lighting* for Feb. 21 last, p. 333, by Mr. F. E. Linging, of Norwich) will compare very favourably with the gas sent out by the London Companies during the same period. The following is the monthly average of the number of grains of sulphur compounds found in the gas supplied to consumers since January, 1887:—January, 1887, 11·98 grains; February, 11·82; March, 8·94; April, 9·63; May, 11·63; June, 11·39; July, 10·71; August, 12·19; September, 13·76; October, 10·98; November, 11·18; December, 9·94; January, 1888, 9·43; and February, 8·05. During the last few months, I have been working our washer of four chambers as follows:—The first and second chambers with strong 18 to 20 oz. liquor; the third chamber, with pure crude liquor, 6 to 8 oz. strength, taken direct from the hydraulic main, without mixing with any of the other liquor; the last compartment, with clean water, a small stream being kept constantly running into it; and afterwards finishing with Mann and Walker's 5-feet scrubber filled with coke. As is usual with this scrubber, clean water is supplied in quantities necessary for the absorption of the ammonia;

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the liquor coming off at the overflow from 5 to 7 oz. strength. I venture to think that the introduction of the pure crude ammoniacal liquor direct from the hydraulic main, must have some effect in reducing the sulphur compounds; as, when the washer was out of action for cleaning, &c., in the latter part of last summer the sulphur compounds were much higher (with a small make of gas) than they have been during the heavier months of the winter—August and September being respectively 12·19 and 13·76 grains, while December, January, and February last are only 9·94, 9·43, and 8·05 grains, using the same description of coals during the whole time.

We have four oxide purifiers—two 16 ft. square, one 16 ft. by 15 ft., and one 12 ft. square—working in rotation, three on and one off for cleaning, by a centre-valve arrangement. Since their erection in 1881, they have been charged with the same material —viz., 70 tons of natural oxide from the Westbury Iron Company's works; and from that year to the present time have passed 235 million cubic feet of gas—the material having increased in bulk to nearly double its original quantity. It seems now to be capable of working for a much longer period, as, during the past twelve months, we only changed six oxide purifiers; each of them passing an average of 7 million cubic feet of gas. After leaving the oxide boxes, the gas passes through two 16 ft. by 8 ft. purifiers charged with lime. These take out a portion of the carbonic acid, not absorbed in the washer, and also catch any small quantity of sulphuretted hydrogen which may escape when changing the oxide purifiers.

You have doubtless seen our sulphate of ammonia apparatus now in action. It is I think equal in efficiency (both as regards the quality of the sulphate made and the cost of manufacture) to any of the more elaborate and expensive systems so often erected. A description of the apparatus, and a few figures as to the results obtained, may not be out of place here. The method of distilling the liquor is by direct firing, which I think is preferable to steam, both in respect to economy of fuel, and also in the production of a better and cleaner salt from ordinary pyrites acid. The boiler is 16 feet long by 5½ feet diameter, and is usually charged with 1500 gallons of liquor. The fire is put under it by the night stoker about two hours before the arrival of the workman in charge. By the time he arrives, the liquor is just beginning to boil, and to liberate the ammoniacal gases. It is during the next two hours that the cleaning of the salt takes place; for, unless the saturator is well boiled, and the dirt constantly skimmed off, the liquor in the saturator will be thick and dark, and the sulphate made will not be clean and white. The saturator we have in use is closed in

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that part where the contact between the sulphuric acid and ammoniacal gas takes place; the fishing chamber being separated therefrom by a midfeather running nearly to the bottom. The size of the saturator is 5 feet long, 3 feet wide, 3 feet deep in the closed, and 2 ft. 6 in. in the open part. We have also two spare tanks, into which is thrown the skimmings of the saturator. A quantity of clean water is mixed with this scum, and allowed to settle, when the dirt sinks to the bottom, and the water absorbs the sulphate or acid contained in it. With this apparatus, one man can produce from 15 cwt. to 1 ton of sulphate in twelve hours, according to the strength of the liquor used; 12-oz. liquor usually making 15 cwt., and 16-oz. liquor 1 ton per diem. When we first began the manufacture of sulphate, labour cost 11s. 1d. per ton of sulphate made; but with practice, we have been able to reduce it to 8s. 6d. per ton, which was the average price for last year's labour. This sum is inclusive of all expenses, not only for labour in making, but packing and delivery into waggons for hauling to the railway station. We find with direct firing that caustic soda is preferable to lime for getting out the fixed ammonia, as the use of an agitator is dispensed with. The average cost of soda per ton of sulphate made is 1s. 6d. Fuel varies a little according to the price at which coke is selling; but 6s. per ton of sulphate made is a fair average. Repairs to the saturator, boiler, store-tanks, sulphate-stores, and tools average 4s. per ton, extending over the past seven years. The total cost of the plant to the end of 1887, inclusive of buildings, was £393.

The following are the quantities of sulphate made per 100 tons of coal carbonized for the past seven years:—For the year ending June 30, 1881, 19·6 cwt.; 1882, 16·5 cwt.; 1883, 19·1 cwt.; 1884, 19·2 cwt.; 1885, 18·9 cwt.; 1886, 16·5 cwt.; and 1887, 20 cwt. From what we have done for the last half year, I think the latter quantity will be fully maintained in 1888. A little explanation is necessary with reference to the small make in 1882 and 1886. In 1882, we only worked up about ten months' make of liquor—an extra month's having been used in 1881 and 1883. In 1886, we found a leakage in one of the liquor-tanks, through which a quantity of liquor was lost; and the effect is seen in the increased make for 1887.

On our *agenda* for the last half-yearly meeting, it was stated that Mr. Osmond, of Dorchester, would invite discussion on the question, "Is it desirable to manufacture sulphate of ammonia at works making less than 20 million cubic feet of gas per annum?" We all know that, if that meeting had not been adjourned for other causes, our friend, through illness, would not have been present to lead the discussion; and his subsequent death prevented

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it when the meeting was held in November. Without entering into further particulars than those I have already given, I should say that, unless a works was so situated in relation to large users of ammoniacal liquor, that a good price could be obtained for it, it is decidedly advantageous to erect plant, on a simple scale, and work up your own liquor into sulphate. Having made our sulphate, the next thing is to sell it; and I should like to hear if any of our friends have been able to find a good sale in their own immediate neighbourhood, and among agriculturists generally. We have spent some pounds in advertising—sending out pamphlets and circulars to all the gentry, farmers, and market gardeners in our own district—but without any results, except it be the sale of a few odd hundredweight.

Our Past-President, Mr. T. W. R. White, will favour us presently with his paper on "Gas Supply and Consumers." Without trenching on his subject, I should like to mention how we have endeavoured to exhibit the use to which gas may be put for other purposes than lighting. Not having an office or shop in the town, as there is in many places, for the special exhibition of gas appliances, and only our store-room on the works in which our stoves for cooking, heating, and boiling may be seen by consumers, I have introduced into my own house, for the past three years, the use of gas for *every* purpose for which fuel is required. It is found to be most useful, not only for cooking and warming, but also for washing, drying, ironing, and airing of linen, and that for a large family. I find that the best recommendation of stoves, for either or all of these various purposes, is in consumers being able to see the different work efficiently performed in an ordinary household. I have sold several stoves to friends and consumers through their seeing them in operation in this manner, as they prefer visiting a private house and making personal inquiries, rather than going to a showroom or shop. For many years we used gas for cooking during the summer months; but it is only since 1882 that we have gradually introduced it for use in every department of household work where fire is needful. So useful has it become to us, that if we had to go back to coal or coke fires, it would be necessary to employ extra help for the household work. It may be of interest to know what extra consumption this alteration has made. In 1882, when gas was used for little else in the house and office except lighting and summer cooking, the consumption for the year was 230,000 cubic feet; and in 1886, the consumption was 307,000 cubic feet—or an increase of 77,000 cubic feet only. Three years ago we had an exhibition of stoves for cooking and heating, which resulted in our obtaining several new customers. For a small town, we have a fair share of patronage in this department, having now 110 stoves

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of various sizes on hire, besides selling many, for both cooking and heating, to those of the consumers who prefer making them their own property.

The Sunday labour question has lately been brought up in connection with two large gas undertakings carried on by local authorities—the question having arisen in one instance as to the possibility or not of dispensing with continuous labour in the retort-house on the Sunday; and the other as to the proper remuneration for such work when it is necessary to be done. Having adopted the plan of stopping work on Sunday from 6 a.m. till 6 p.m. for the past twelve years, I thought it might be useful if I gave the result of my experience in this matter. I would first say that our storeage is only two-thirds of our maximum consumption; yet, owing to its peculiar character during the winter, we are enabled to dispense with Sunday labour without any difficulty. Our heaviest days are from Monday to Friday. There being no mills lighted on Saturday evening, we gain a good quantity of stock; so that on Monday morning we usually begin with the holders nearly full, although no charging has been done for twelve hours on the Sunday. We take the opportunity of making Sunday the day for the change from night to day work. The night men of Saturday beginning as day men on Monday morning; and the day men of Saturday starting as night men on the Sunday night. When we commenced the alteration, we did not reduce the wages, but made the payments for thirteen turns in the fortnight equal to the amount paid for fourteen turns before. Since 1876 we have only had to work occasionally through the Sunday; and when we do, I always endeavour to make up a set of men out of the yard, so that the ordinary stokers may have their accustomed rest.

I will now briefly name what I consider to be the advantages of this change. The men are more contented with their work, and endeavour to keep up the gasholders during the week, so that no extra work may be required on Sunday. They are more sober and thrifty in their habits than formerly; many of them valuing the privilege of being able to attend public worship on the Lord's Day with their wives and families. The men are physically better for the rest. Before it was introduced, there was someone away almost every week through illness; now, with a larger number of stokers employed, we go on for weeks without any one missing a single turn. As there are many managers present who have works about the same size as my own, I would commend this question to their consideration; and if they have not hitherto adopted the principle, I trust they may be encouraged to give it a trial.

The time at our disposal to-day is somewhat limited, owing to

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the early hour at which we are obliged to fix our luncheon to enable friends to leave who reside at a distance; and seeing we have three papers on very important subjects to be read and discussed, I will not weary you with any remarks of my own on the various topics animating the gas world at the present time. These have been most ably treated, in the masterly and exhaustive addresses delivered by the Presidents of kindred District Associations at their meetings lately held. Moreover, the manager of a small country works has his time fully occupied with little matters of detail, superintending workmen, seeing customers, and the many other things which in a large works are directed by the heads of the various departments; and thus leaving the engineer and general manager time and opportunity for research and inquiry, the result of which he can give to his more engaged brethren.

I have endeavoured to give you a few details of our own working in some of its most interesting parts. Doubtless, there is little or nothing new in them; but I take it that our object in coming together to these meetings is to talk over with one another what we do and how we do it, rather than entering into the discussion of theories, which may or may not be correct. I trust our deliberations to-day will not be less fruitful than those which have gone before; and that there will be a full and free conversation on the various subjects now to be submitted. Let no member hesitate to express his opinion, or the results of his experience, in relation to the several matters to be brought under our notice; and we shall return to the discharge of our duties the better informed for having thus met.

Mr. W. A. PADFIELD (Exeter) thought that the President had delivered a very instructive address that would well merit careful perusal. He proposed a hearty vote of thanks to him for it.

Mr. T. W. R. WHITE (Sherborne) seconded the proposition, and it was carried by acclamation.

The PRESIDENT briefly acknowledged the vote.

Mr. J. J. JERVIS (New Swindon) said that various circumstances had intervened to prevent him from preparing a paper on "The Hydraulic Main," as announced in the programme; but he would undertake to read it at the next meeting. In place of the promised communication, he would read a short paper entitled

A FEW NOTES ON SULPHATE MAKING IN SMALL WORKS.

At the Southampton meeting of this Association our esteemed friend the late Mr. Osmond proposed for discussion the question, if I remember rightly, "Will it pay gas companies making less than

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20 million cubic feet of gas per annum to work up their ammoniacal liquor into sulphate?" I intimated at the same time that I would give one reply to the question. My intention was simply to describe a small plant for a gas-works making about 4 million cubic feet per annum, and to show that it must be a very small works indeed that could not profitably work up the liquor produced—at any rate, that it was better than throwing it away, or almost giving it away to avoid nuisance. I do not therefore intend to read a paper on sulphate making; but simply to detail a little experience, which may possibly be interesting to managers of small works.

We started sulphate making eight years ago, when our annual make of gas was about 12 million feet; and I think it paid us better then than it does now that we have doubled our business. Prices were higher; but even now our sulphate means about 14d. net per ton of coal carbonized, whereas if we had to sell the liquor we should not make 4d. per ton. Our sulphate-house is built of brick, and has a slated roof; but I am of opinion now that the house should be entirely of wood, coated inside and outside with pitch. Of course, you will understand that I am speaking more particularly of plant for small works. Brick buildings suffer much damage—the mortar swells from absorption of acids and gases, the bricks crumble, and the slates and tiles rot. Well pitched wood will stand acid and ammonia water, &c., as long as you like; and a tar and ash roof of about 1½ inches in thickness, laid on boards and well trowelled over, will look as neat as a slate one, and outlast a dozen of them. Besides a wooden building is soon run up, and costs less than a brick one. The floor gives some trouble; but a good cement and clinker pavement stands very well. It is advisable, in case the saturator should "spring a leak" at any time, to have at least that part of the floor about it lead lined and dished, and with a good sized sump-hole; so that if the whole contents of the saturator should run out, they would not spread all over the house.

With respect to the liquor boiler, I should like to know the greatest distance it may be situated from the saturator. Much setting of brickwork, perhaps stack, &c., might be avoided under certain circumstances; and it might materially assist to be able to place the boiler in one place, the saturator in another, and so on. Our boiler is close alongside the saturator, and is heated by a steam-coil. This is very convenient, providing your steam-boilers are full sized for their other work. We have no valve or cock in the ammonia take-off pipe. It is not absolutely essential; and it may be very much in the way if forgotten. The peg-hole in this pipe is, of course, very handy as a rough-and-ready way of knowing

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what is going on; but it may have another use. By omitting on one occasion to take out the peg when boiling up was finished, several inches of the saturator contents "went over" to the boiler by special invitation of vacuum as the boiler cooled down. In filling the boiler with liquor, we used to pump direct from the well; but once we were fairly "caught out." The pump drew tar, and then naphtha must have come over into the saturator, and, floating on the top, vapourized, caught fire from the gas-jet overhead, melted the feather, &c., and was a general nuisance—nearly causing a "flare up."

Some sulphate makers have a large liquor settling-tank, so that the tar may separate; but as expense must be considered in small works, we have made a very good separator out of two paraffin empties (costing 2s. 6d. each); the pipes and patent T-cocks, of course, being extra. The filling-pipe should not be coupled up to the boiler, as then the same pipe (provided it be carried nearly to the

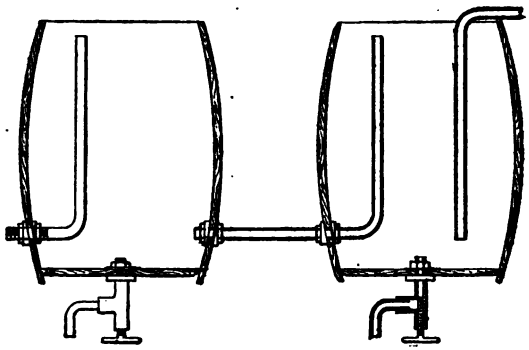

FIG. 1.—SECTION OF TAR SETTLING-TANKS.

bottom of the boiler) may be used for liming or putting in soda at any time during the boiling down. The discharge of the liquor from the boiler is in some works accomplished by steam pressure; but as this necessitates a valve in the ammonia take-off pipe, we syphon it out, and so avoid carrying any pipe through the brick-work. The syphon is charged, of course, as the boiler is filled; and by opening the T-cock, it is put in action. The exposed part of the boiler, and indeed every part of the sulphate plant, should be well pitched. For carrying acid, an ordinary bucket will last months if well tarred.

With respect to the saturator, I should like to have the opinion of members as to the weight of lead for lining—which is best, 8, 10, 12, or, as I have seen some, 20 lbs. to the foot? and also, What are the merits of cast-lead saturators, or are lead-lined wooden boxes best? I think that heavy lead bulges, and cracks sooner

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than the lighter lining. Then, as to the size, I know of no rule other than that it is better to have the saturator too small in respect of the boiler than too large for it, as, in the latter case, one can make plenty of mother liquor, but very little salt. A friend once came to me who had suffered in this way. We agreed that a small steam-coil at the bottom of the fishing-box would keep down the excess of water and aid the production of salt; and it did so admirably. The diagram shows the detail of a saturator

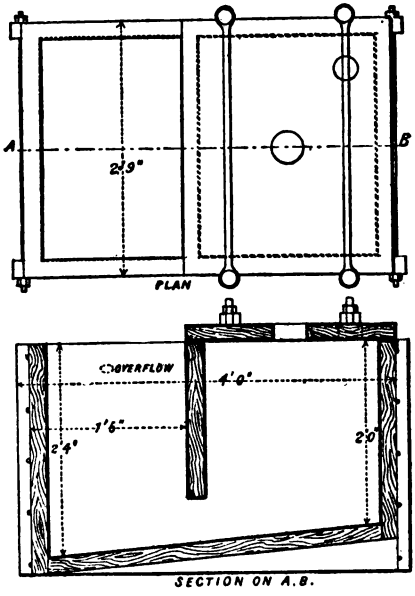

FIG. 2.—SATURATOR.

we have just made. The boiler works off about 600 gallons at a time. We do all our lead burning with a Fletcher blowpipe, using ordinary coal gas, with a small holder of about 5 cubic feet capacity as the air blower.

We have no acid tank. It saves expense and a lot of trouble; and we get through our work very well without it. Before beginning to boil up, we make up the saturator to 65° Twaddel, and add acid afterwards, as wanted, through a small feed-pipe, keeping the saturator at about 60°. Some of us who are not chemists, nor have any aptitude for testing, would like information upon the best Twaddel point to work at, so as to keep squarely up to the market percentage. A spare lead-lined tank is handy close to the saturator for skimmings, if pyrites acid is used, but is not so necessary if brimstone is preferred. An excellent white salt can, however, be

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made with the former acid; but more care and labour are required, and for the difference in cost of acid is perhaps hardly worth the trouble. The bank or salt-storing floor should, of course, be as close as possible to the saturator. If the building is constructed of wood, there is no further need for match-boarding round it; but if of brick, the walls should be well tarred. On the lead lining of the floor we lay boards, as this aids the draining of the salt, and saves injury to the lead when bagging up, &c.

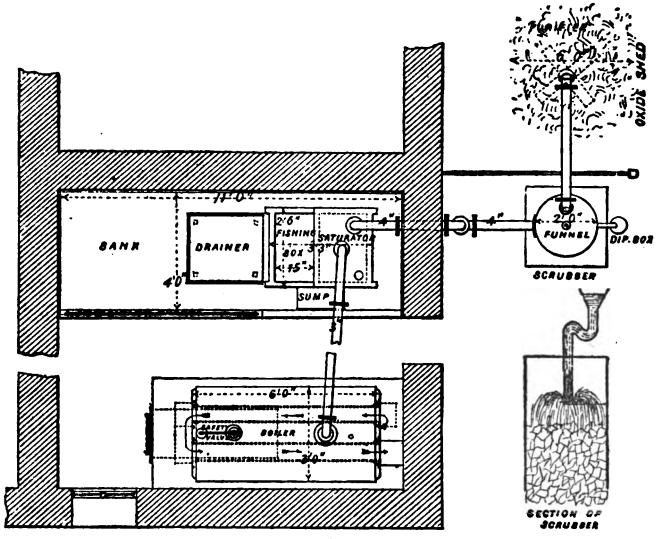

FIG. 3.—PLAN OF SULPHATE PLANT.

Referring again to the saturator, we carry the take-off pipe for sulphuretted hydrogen to a scrubber, which is a tube 2 feet in diameter and 20 feet high. The lower part is filled with brickbats, &c., to make it stand firmer, and the top part with coke. A stream of water is pumped into the scrubber, and distributed very fairly by falling on to a disc, shown on the diagram. As the water falls into the funnel, some air may be drawn in, and pass on to the purifier to play a part in continuous revivification. From the top of the scrubber is taken a pipe, which may be any length desired, and carried to any suitable place. In our case, it is conducted to the oxide floor, and terminates simply in a heap of oxide; and this is all the purifier arrangement we find necessary. Any distributing channels required may be easily made by a few bricks and a grid or two; and if complete revivification is not going on, there is every chance of it from so much exposure.

The above diagram shows the plan of a little plant, upon the same lines as our own, which I have just erected for a gas-works making

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less than 4 million cubic feet per annum. It is certainly simple enough; but it does its work. About 2 tons of salts were made in a month, with no particular strain upon the time of the man at the gas-works. Referring to these works in his report, Dr. Fryer, the Government Inspector, says: "No —— is a small works, where not more than 400 tons of coal are carbonized per annum; and an ammonium sulphate plant has been erected here recently by Mr. John J. Jervis, Manager of the New Swindon Gas-Works. A coke scrubber is made use of, instead of the enormous length of cooling and condensing pipes usually considered necessary; and an arrangement is made for sufficient air to be carried to the purifier, in order to revivify the oxide of iron. The purifier merely consists of a heap of oxide of iron, and the pipe conveying the sulphuretted hydrogen is brought through the centre of the heap downwards, terminating in four radiating channels made by loose bricks covered with an ordinary purifier grid. This form of purifier is not only simple and inexpensive, but also does its work effectively." The cost of the apparatus was under £50 (exclusive of an outhouse); and I have no doubt whatever that it will pay well. This, however, I must tell you at another meeting. In small works, and even in moderate sized works, the item for the licence is most unsatisfactory. We pay about 2s. 6d. per ton, and the little works in question will record 12s. per ton; while perhaps some of the works represented at this meeting do not pay 6d. There ought, I think, to be a sliding scale.

In these few "Notes" I may not have spoken of anything unknown to many of you; but perhaps what I have said may be of interest to some who are not makers of sulphate. They will see it is certainly possible that, by cutting out all but absolutely necessary parts, procuring a good serviceable second-hand boiler and a vessel as a scrubber, and arranging the plant as far as possible in existing buildings, a cheap and effective apparatus can be had, and the making of sulphate become a very ordinary work. The high results obtained from the elaborate plant some of you possess will not, of course, be attained; but very good results will ensue, and small works may compare with large ones as favourably in this department as in others.

Discussion.

The HONORARY SECRETARY remarked that the ordinary Twaddel hydrometers, as used for testing ammoniacal liquor, could readily be examined for accuracy by immersing them in pure water. If accurate, they should, under these circumstances, float at exactly the zero line. If a hydrometer so tested indicated (say) $1\frac{1}{2}°$, it would be $1\frac{1}{2}°$ too high; and if a liquor tested by it indicated $7\frac{1}{2}°$, the true strength would be 6°. A few experiments with a few

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ordinary No. 1 hydrometers would, he thought, convince anyone of the desirability of making this preliminary experiment before using the instruments for any purpose in practice.

The PRESIDENT thought that Mr. Jervis had favoured the meeting with some very useful notes, following up one of the points he had referred to in the address. As to the thickness of sheet lead, he considered 20-lb. lead—20 lbs. to the foot super.—far preferable to 12-lb. He had known rather thin lead to be used; and it bulged, and required continual alteration and repair. His saturator, lined with 20-lb. lead, was put down five years ago; and nothing had since been expended upon it for repairs. He thought the overhead acid-tank a very desirable adjunct; having experienced difficulty in working without one. He also preferred to fill up the boiler from an overhead tank, as at first he had a self-acting syphon arrangement direct from the outlet-pipe into the scrubber. One day this became unsealed by some means; and the gas escaped directly into the boiler—an accident which might have resulted in a disastrous explosion.

Mr. E. J. BARNFIELD (Chepstow) was then called upon by the President to read his paper on

STOPPAGES IN ASCENSION-PIPES.

He said that he was present that day under disadvantageous circumstances. In the first place, his health was extremely indifferent; and, in the second, he had lost the manuscript of his paper in the course of his journey. He must therefore ask for the kindly forbearance of the members. Having promised to attend and take part in the business of the meeting, he had feared his absence might cause some inconvenience. Fortunately the points which he had written down for submission to the meeting were few, and he could remember them. Previous to accepting the appointment he now held at Chepstow, he had 14 years' experience as Manager of gas-works; and in the course of this period, he never had to deal with anything in the way of a stopped ascension-pipe—just a little deposit close to the mouthpiece or in the bridge-pipe being all he had to encounter. He was at Swanage for five years. Before leaving, they had all the caps on the ascension-pipes, &c., removed, to make sure that all was clean and in order; and they also cleaned out the hydraulic. There was not the slightest sign of any deposit in the pipes. He would mention that the retort-house was large in proportion to the number of retorts—being 66 feet long by 33 broad; and there were only seven retorts—one bed of three and two beds of two. There was a continual down-draught, which kept the house quite cool; and he would also call

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attention to the fact that the pipes were well away from the brickwork of the setting—there being a clear space of 6 inches or so between them.

The very day he commenced duty at Chepstow, he found out what stopped ascension-pipes were. A man was kept almost continually at work driving red-hot bars down the pipes, and using other expedients to keep them clear. The whole of the pipes about the works were heavily charged with naphthalene; and the outlet from the meter was completely filled with the crystals. Having cleared these, he turned his attention to the retort-house, which was small and badly ventilated; the heat and foulness of the air during charging times being very oppressive. It contained two beds of five, and one of four retorts; and the pipes in the outside bed of five gave the most trouble. These were fitted with an anti-dip arrangement; so that the hydraulic seal, excessive or otherwise, could not be concerned in the matter. The middle bed of five gave scarcely any trouble at all. The pipes were the same size as those in the other bed of five—6-inch—but were not set so close to the brickwork. Three of the pipes in the bed of four gave a great deal of trouble; but the fourth never stopped at all. The pipes in the last-named bed were not only very small (being only 4 inches diameter), but were placed so close, and inclined towards the setting, that they nearly touched the brickwork at the top. In inquiring into the circumstances of the pipe that did not choke, he found it was very much cooler than the others. There was a ventilator in the wall, which admitted cold air close to it.

His first proceeding was to ventilate the retort-house by erecting a shaft 10 feet high, and 21 in. by 11 in. in section. This being done, a steady upward draught obtained in the front of the settings; and the stokers were able to work in much greater comfort. He also brought a 6-inch pipe through the wall from the outside, in a horizontal position, just below the mouthpieces of the bottom retorts, and made holes on its upper surface, so as to allow cold air to ascend on the exterior of the ascension-pipes. In addition, he introduced a water supply at the top of the ascension-pipes, with a swan-neck and a little regulating device, to allow a continual dropping of water down the interior of the pipe. It was not a stream, but merely a dropping like rain. A small bell or cone was suspended close to the nd of the water-pipe by a piece of copper wire; and the water trickled down the outer surface of the cone and dripped from its lower edge. He did not find that the cold air or water lowered the heats. The working had not been altered in any way. He continued to use Newport coal exactly as before; but since completing the arrangements above described, he had not experienced even a single stopped ascension-pipe.

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Discussion.

The PRESIDENT was sure that all present felt greatly indebted to Mr. Barnfield for coming forward, in spite of the unfortunate circumstances under which he was labouring, and that they wished him a speedy return to health. He had stated his experiences very clearly; and the subject was well worthy of discussion.

Mr. J. J. JERVIS said that, by taking care not to have any excess of heat in the retorts, he was able to avoid the trouble caused by choked pipes, and had not had half-a-dozen during the past winter. The additional yield secured by high heats was, in his experience, more than counterbalanced by the loss and trouble due to stopped ascension-pipes. He also flushed the hydraulic with warm water once or twice a week. He had tried the plan of dropping water down the ascension-pipes, and also of placing a shovelfull of wet coal in the mouthpiece; but neither of these plans was successful. It appeared to him that an important feature in the method which had been adopted by Mr. Barnfield was that a slight reduction of the heats was thus induced.

Mr. PADFIELD quite agreed that high heats produced choked pipes. He had partly remedied them; but still if the make ran high he was always troubled with stoppages in the ascension-pipes. It would be remembered that two or three years since, Mr. Crowe read a paper before the Association describing a device he employed for admitting water at the top of the ascension-pipes, which was claimed to be a preventive of stoppages;* and he (Mr. Padfield) had since adopted a similar arrangement. It required some attention, however; and he considered that everything at the top of the retort-bench should work as automatically as possible.

Mr. H. G. CROWE (Wellington) said that the plan alluded to by Mr. Padfield continued in operation at his works; it answered well, and was perfectly successful. It made him feel rather uncomfortable to talk about checking excess of heat; for he believed that the heats should be well maintained. This little apparatus—which could be fitted up for about 10s. per mouthpiece—proved a complete remedy for choked pipes; and therefore he had no occasion to resort to any other expedient. In one corner of the retort-house, close to the roof, he fixed a small tank holding 100 gallons of water. From this a 1-inch wrought-iron pipe was carried across the retort-house over the bridge-pipes; and a $\frac{3}{8}$-inch branch, with tap, was taken off for each pipe. A small swan-neck funnel conveyed the water into the interior of the pipe; and it was easy to see from the floor whether or not the water was dripping. A very small quantity was required—merely a dropping; and when the lid was off, it could be seen falling in the mouthpiece. The stokers

* See "Reports of Gas Associations" for 1884, p. 79.

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were very glad, for their own sakes, to take care that the water supply was maintained; and it did not cool the retorts in any way. He could strongly recommend it; and he thought that if it was tried, there would be no occasion to keep the heats back.

Mr. S. W. Durkin (Southampton) said that the idea of a draught of cold air preventing stoppages in the ascension-pipes was corroborated in his own experience. He had through retorts, with ascension-pipes at each end; and the direction of the wind had a great effect in this matter. If it blew in on one side, then that side was cooler than the other. The wind played on the ascension-pipes, and drove the hot air to the other side. He never had any choked ascension-pipes on the windward or cold side; and it appeared to him that Mr. Barnfield had practically realized this action of the wind. The ventilator maintained a continual up-draught. He did not quite understand the advantage of lowering the heats to prevent chokes, as proposed by Mr. Jervis, as he went in for high yields, and would not care to reduce the heats; he would rather put up with stopped pipes. No doubt the kind of coal used—some used inland coals, and others sea-borne coals from Durham and Yorkshire—had an influence in the matter.

Mr. J. H. Hopper (Glastonbury) observed that some years ago he was much troubled with stopped ascension-pipes. After trying coke and other expedients in the mouthpieces, he accidentally hit upon the plan of putting in a handful of oily waste; and this proved very successful. Mr. Jervis suggested to him that the use of fat in the mouthpiece formed the subject of a recent patent; but he had tried this plan long before the patent alluded to was taken out, and should continue to use it.

Mr. A. Edwards (Taunton) remarked that he had not known what a stopped pipe was in his works for twelve years. He thought the various remedies that had been suggested ought not to be required in the first place, because, by careful attention to one or two points, stopped pipes would never occur. If the retort became so hot as to decompose the gas in the course of its passage through the retort, then carbon would be deposited in the pipes. Light charges, worked off perhaps an hour before the lid was slacked, were therefore a fruitful cause of stoppages. If care was taken that the heats—either in parts or throughout—were not more intense than was sufficient to get all the gas out of the coal, they would not occur. He filled his retorts to within 2 or 3 inches of the crown; and yet never had a choked pipe. If a retort that had just been scurfed, and was therefore rather above normal heat was charged lightly, a stoppage would assuredly result; and therefore he had the freshly-cleaned retorts charged with small heavy coal. In some cases the kind of coal used had an effect. He might say

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that he had carbonized nearly 100 different sorts; and he once had a Somersetshire coal that was very liable to cause choked pipes. The reason was that this particular kind of coal did not require so much heat to evolve the gas as others. It was worked off long before the proper time for charging. By reducing the heat, he was able to stop the chokes; and yet to maintain a good yield of gas. He took care to have large ascension-pipes—6 to 7 inches in diameter; and he believed that the slight extra expense, as compared with 5 or 6 inch pipes, was returned over and over again.

Mr. H. F. WILLEY (Exeter) thought that it could not but be very prejudicial to reduce the heats. No doubt it was well to have the ascension-pipes of ample area; and also to take care to keep them well away from the front of the setting.

Mr. T. HARDICK (Salisbury) remarked that it was all very well to talk about large ascension-pipes; but this was not going far enough. There must be large exits from the hydraulic, and so on throughout the connections right on to the holder. It was no use to have (say) 6-inch ascension pipes, and only a 5-inch outlet from the hydraulic. With some free-working coals, the gas came off with great rapidity at first; and there should be nothing to hinder it from passing freely away. When he first went to Salisbury 30 years ago, choked pipes were the rule. The stokers received an allowance for each pipe they had to clean; and this sometimes reached £2 per week. He found the coal had nothing to do with it; and the cause was certainly not high heats. The simple fact was that the outlet from the hydraulic was too small; and when this was set right, there were no choked pipes.

The PRESIDENT said that the efficiency of cold air as a preventive of choked ascension-pipes had also been illustrated in his experience. Some years ago he took down the wall close behind the settings, and carried it back so as to form a coal store, and, when necessary, space for more retorts. Since this had been done, there had not been so much trouble with stoppages, although the kind of coal used, and the method of working, remained exactly as before. He had tried wet coal, and also running a stream of water down the ascensions, without much benefit.

Mr. BARNFIELD, in reply, said he was pleased to find that so many agreed with the plan he had adopted. He had never seen a particle of naphthalene in any part of the works since he cooled the retort-house.

Mr. T. W. R. WHITE (Sherborne) next read a paper entitled—

GAS SUPPLY AND CONSUMERS.

The object of my paper is to lay before you some ideas of mine, which will, I hope, be thought by you of sufficient importance, the

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more especially if certain existing and felt needs are mentioned, to raise a good discussion. The title of my paper is not exactly what it should be, perhaps; but as it is on our programme, I have taken it as it stands, and what it lacks will, I trust, be mentioned or brought by you to it in the discussion. I am not claiming in any way to be in possession of any facts or information but what may be known to all, and based on recent experience.

The engineers, managers, and secretaries of gas-works are quite aware and alive to the fact that the industry they manage and control has been periodically threatened. Electricity is coming to the front again and again, and will be trying to wrest from us the public lighting of our streets and our ordinary consumers by an arrangement of house-to-house installation. Petroleum and kindred oils are being pushed upon the public by many, who claim for each separate article special advantages not generally known, and which they say only want to be known in order to be appreciated. If gasmen have in the past done well for their shareholders and consumers, they may well take courage; but they must do better in the future. Some may say "let well done alone;" but really, gentlemen, this will not do, if we mean to maintain our own, and carry out the injunction, "Let there be light." We cannot, we dare not, boast as one may who taketh off his armour. Our call to duty means putting the armour on afresh, and seeing to it that we leave no vulnerable points, which may give our enemies or competitors any vantage.

In the immediate future, we are to hear more about electric lighting companies. As you are doubtless aware, a Bill entitled "The Electric Lighting (1882) Amendment Bill" was read the second time in the House of Lords, on the 5th of March. [Mr. White here quoted from the discussion in the House of Lords on the occasion alluded to, a report of which appeared in the *Journal of Gas Lighting* for March 13, 1888, p. 473.] If our Legislature pass the Bill, and proper protection is not given to the gas property of this kingdom, we shall be called upon to petition Parliament in our own common interest. But if no undue preference is given to electric lighting, and the arrangements made are on parallel lines with gas legislation, we must be satisfied that the race begun will end in the survival of the fittest; for John Bull will weigh the rival competitors in the scale of £ *s. d.*, and the verdict of "what won't pay, won't do" will be given.

Petroleum and kindred oils are at the present moment very close competitors with gas in small towns and villages; in large towns too, and also in many of our suburban populous districts. The *Darwen News* of less than a month since said: "We have heard, though we hope it is not true, that there are no fewer than 1800

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gas-meters in private houses scattered all over the borough that are silent or not used. In other words, there is that number of inhabitant householders who prefer to obtain what artificial light they require during the long dark evenings of winter from oil rather than from gas." Do we not find in the towns represented here to-day that oil is our great competitor? Lamps, good in design, and presenting a very pretty appearance, can be procured as low as half-a-crown each; and as one lamp often does duty in two or three rooms (being moveable), the capital outlay to a newly married couple furnishing is not very heavy. Petroleum can be had at from 10d. to 1s. per gallon; and it is even hawked about the towns and villages during the hours of the day, and retailed pretty much in the same way as milk. The wage-earning classes are the very best supporters these hawkers of petroleum have; they go from hand to mouth. A lamp is a lamp; and a gas-light is a gas-light. They possibly have not taken the trouble to look into the matter, and find out, by comparison, which is the cheaper light. Any information you may place in their hands would very speedily be consigned to the flames, when they found that, in order to reduce the lesson received to practice, they would have to spend (say) a couple of pounds, or thereabouts, for the necessary fittings to obtain gaslight.

In order, therefore, to obtain new consumers among the working class, or keep those we already have, we must meet the demand of the times. But what I contend for is the necessity of all gas companies doing the best they possibly can to secure the largest possible sale of the gas over the area of which they have the entire monopoly. The cost of laying on gas should be reduced to a minimum. In the case of a small house—a workman's dwelling—the cost of lighting it during the winter evenings comes in. You have to put down for lighting with gas a first cost of (say) from £2 to £2 10s., as against 7s. 6d. for lamps—of course, I am assuming that gas is not already laid on. Gas managers would do well to carefully watch all new buildings in course of erection in their various towns; and if they find that any villa, cottage, or tenement is being built beyond a rent of £10 per annum, and there is not any arrangement for laying on a gas supply to the structure, to make an offer to do it at cost price. The gas should be laid on to a position which, by experience, has proved the most convenient in small dwelling-houses. The day is, I believe, past for putting in ½-inch service-pipes; the service-pipes should in all cases be not less than ¾ inch diameter, with main tap and connections full bore to the inlet of the meter.

Here I would suggest the advisability of all meter-unions being of ¾-inch full bore for 2-light, 3-light, 5-light, and 10-light meters,

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and of the same size and pitch in the threads and connections. So that if a 2-light meter had to be superseded by a 5-light one, or a 3-light by a 5-light or a 10-light, the exchange could afterwards be made without any expense to the gas company or the consumer. The uniform size of ¾-inch full bore for meters up to 10-lights might slightly enhance the cost of the smaller meters; but the convenience of being able to make any alteration or interchange of meter without expense, would more than compensate for the possible extra few pence charge for the unions. All unions, tees, crosses, caps, and linings of all makers should be of one uniform and standard size and pitch, so as to reduce the cost of interior fitting to a minimum. A pipe leading through to the kitchen or scullery should not be less than ⅝ or ½ inch bore; so that if perchance a cooking-stove was fixed, a full supply could be ensured.

It is very annoying to find such variations existing in the size of burners. Sometimes a ⅜-inch burner has to be connected to a bracket having a $\frac{7}{16}$-inch nozzle, or a $\frac{7}{16}$-inch burner has to be connected to a ⅜-inch bracket nozzle. Such things should not be, and in giving out our orders, we ought to insist upon a certain ⅜-inch uniformity of pitch of thread, or reject all goods which do not conform. These matters may be termed trifling. But suppose, for example, a customer selects some Christiania or Peebles burners or others of any equally good makers, they are sent out in the hands of a fitter for attachment, who returns to the works and explains that he requires some small fitting by way of an adaptor before he can fix the burner; and as it was rather late in the afternoon, the lady of the house said she would rather he came at 10 o'clock the following morning to do what was necessary. Had there been uniformity, the second call of the fitter would be quite unnecessary; but I take it that the result is that the consumer has to bear the cost of two visits of the fitter instead of one, as in any well-regulated works the consumer is charged with the whole of the time entered against him or her on the fitter's time-sheet. This increases the cost of lighting by gas, and is chronicled against us by the party who "pays the piper." Let us use every means in our power to reduce legitimately (I use the word advisedly) the cost of laying on gas, of maintaining the supply when laid on, and of supplying gas of uniform quality and quantity. It must be a matter of regret to most managers of gas-works that so many workmen's dwellings are not lighted with gas. In Sherborne there is a row of 86 cottages of a rental of £12 per annum, only one of which is lighted with gas; and recently six villa residences were built, bearing a rent of £24 per annum, none of which were supplied with gas, but two of the tenants have since gone to the expense of laying it on. The whole six houses ought to have been arranged for a supply by the

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landlord in the first place. I think it behoves us to endeavour to secure if possible that all new buildings shall have a proper provision for a supply of gas; and, if needs be, the fittings should be put in at cost price.

Respecting the necessity of meeting the sale of petroleum in small quantities on its own footing, I contend, if it is worth the while of the oil seller to supply it in small quantities, we should consider if it would not be to the advantage of gas companies to have an arrangement for reading the meters in workmen's houses weekly, when the money due could be paid, and properly entered. The wage-earning class pays well as a class; but many are averse to running bills, and would perhaps consent to burn gas at a charge of 6d., 8d., or 1s. per week, rather than have a quarterly account amounting to 7s., 8s., or 13s. We do not like to find our consumers giving up the use of gas for oil. Only quite recently I received peremptory orders to remove a 20-light meter from the premises of a grocer in our town, who stated that he was going to use oil. He circulated the report that he was about to save £20 per annum by the change; but considering his payment for gas during 1887 was £12 15s. 4d. only, it is evident he is about to be paid a premium for burning oil.

I would say, in conclusion, that I shall be satisfied if this paper is found to promote a discussion, and that we each shall return to our respective spheres of duty resolved that, come what may, we will not be beaten in competition in supplying the much-needed necessity of life—light.

Discussion.

The PRESIDENT said that the subject introduced by Mr. White was a very important one, calling for a full and free discussion. Country gas managers need not trouble much about the electric light; but they had to consider how to act as regarded the oil question. Unfortunately the time for closing the meeting was drawing on; and he did not think they could do justice to the several points raised by Mr. White that afternoon, so he would suggest that the discussion be deferred till the next meeting. If Mr White would consent, he would propose that course to the meeting.

Mr. WHITE observed that he was quite in the President's hands; but thought a postponement of the subject would, in some degree, rob it of the interest attaching to it. Some other member might again introduce it on a future occasion.

Mr. CROWE said that the postponement of the discussion would afford the members an opportunity for reading the paper and studying the subject at leisure; and he thought it would be advantageous to all to defer it.

Mr. PADFIELD remarked that he considered it hardly possible to

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do justice to the subject in the brief time remaining at disposal; but as there appeared an evident wish to proceed at once with the discussion, he would not waste time. He thought with regard to Darwen that the price and quality of the gas supplied was an important point. He saw no objection to laying service-pipes up to 60 or 70 feet in length without charge, but would hardly go so far as to do all kinds of fittings at cost price. There should be a slight margin—say, an addition of 5 per cent. all round. This would get over the charge of underselling gas-fitters—a class that should not be entirely shut out. He felt strongly that gas companies should do fitting work also, and had brought the matter before his Board some fourteen years ago. The system of weekly payments would increase the cost of office work and collection; but he was glad to support any plan that would augment the sale of gas on a given length of main, provided that it could be adopted with profit. He knew instances of most exorbitant charges made by gas-fitters—as much as £15 for putting in two or three burners; and this did an immense deal of harm as regarded the demand for gas. So he thought gas companies ought to have some control or influence in the matter of gas-fittings.

Mr. JERVIS considered that one advantage of reading the meters at more frequent periods—and that all round, and not for weekly or monthly consumers alone—would be much better supervision and the consequent detection of meters that were slow or stopped.

Mr. EDWARDS felt that the paper could not be adequately discussed, as it comprised many points upon which he should like to have entered, did time permit. He supported uniform sizes for fittings and meter connections, which would greatly facilitate the changing of a meter for the next size larger in cases of inadequate supply. At present this could not be done without cutting the joints; and where, as was the case at Taunton, they did not employ regular fitters, it meant calling in a gas-fitter, and a cost perhaps of 5s. or 6s. No doubt the numerous sizes of fittings added to the expense of putting in new work, and served to bring gas into discredit, as an extra 6d. or 1s. was often thought more of than a large gas bill. People not only objected to the cost, but also to the inconvenience of having a gas-fitter about the house taking up boards, &c. It would be advantageous if the Association could bring pressure to bear in the direction of uniform sizes of meter connections, and the adoption of an agreed standard by all the different makers.

Mr. J. H. HOPPER said he was a gas-fitter of 32 years standing and had perhaps 400 different kinds of gas-fittings in his showroom. All th burner connections were §-inch; and the fitters carried taps, &c., so as to be able to alter them on the spot if necessary.

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The PRESIDENT remarked that he had also met with instances of gas-fittings being put in by "jerry" men, perhaps with a heavy charge in the first place. The result was a high gas bill, and continual expense and annoyance for repairing leakages, &c.; and in the end the use of gas was thrown up in disgust, causing not only loss to the individual consumer, but generally getting the gas a bad name. It was therefore a question well worthy of consideration how far gas companies could control the fittings. He liked the idea suggested by The Gaslight and Coke Company, who contracted with the builders of workmen's cottages for putting in the fittings, without taking any responsibility, at a moderate rental. Something of this sort was necessary in order to secure the working classes as customers; and, in his experience these people were the most prompt in their payments. He knew a street in Trowbridge inhabited by artizans, where 75 per cent. of the accounts were always paid at the first visit of the collector. He heartily endorsed the idea of one size of connection for meters ranging from two to ten lights. He had been told that monthly payments were a general thing on the Continent.

Mr. WHITE, in replying upon the discussion, said that the price of gas at Darwen was low, which made the matter the more lamentable. Speaking from his own experience, after having carried on gas-fitting for many years, it was impossible to give satisfaction in every case. No doubt the best way to retain customers was to make the fittings as cheap as possible. Look how cheap oil-lamps were! They were to be seen—and smelt, too—in many houses. In cheapening fittings, the object in view must be taken into consideration. He did not propose to work at less than the cost; and he thought it wise to work without profit, if in this way he secured a new customer, who would pay perhaps £10 or £20 per annum. It was the business of gas companies to sell gas; and they were quite within their province in doing fittings at cost price, or anything else that would aid to the end. It was very necessary that the customers should be able to avoid exorbitant charges for gas-fittings, or unnecessary expense and annoyance for repairs.

VOTES OF THANKS.

The PRESIDENT said it was now his duty, as it was his pleasure, to move a vote of thanks to Messrs. Jervis, Barnfield, and White, for their interesting and useful papers, which, together with the discussions, had occupied the time very pleasantly, and also, he trusted, profitably.

Mr. J. H. GRAY (Weston-super-Mare) seconded the motion, which was cordially agreed to.

Mr. CROWE said the meeting must not omit a vote of thanks to

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their worthy President, who had done so much in the way of making the meeting a success. The business had been admirably carried through; and he had much pleasure in congratulating him, and proposing a vote of thanks for his services.

Mr. PADFIELD seconded the motion, which was carried with applause.

The PRESIDENT having briefly replied, the meeting terminated.

The members subsequently partook of luncheon at the George Hotel, on the invitation of the Directors of the British Gaslight Company, Limited.

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SCOTTISH GAS MANAGERS.

ANNUAL MEETING, APRIL 12.

The Fifth Annual Meeting of Scottish Gas Managers—held in virtue of an arrangement which has been fully explained in previous volumes of the "Reports of Gas Associations"—took place at the Langham Hotel, Glasgow, under the presidency of Mr. J. M'CRAE, of Dundee.

Mr. M'CRAE opened the proceedings by delivering a short, but very interesting address, in the course of which he touched upon questions of much importance to the gas profession. After apologizing for occupying the position of Chairman of the meeting, seeing that he had not been in any way connected with the late West of Scotland Association, of the members of which that was an informal gathering, and expressing the hope that this fact would not militate against the interest of their deliberations, he addressed the meeting on the following subject:—

REGENERATIVE FURNACES AND SUNDAY LABOUR.

Commencing at the retort-house, which is the beginning of a gas-works, I have great pleasure in noting that regenerative furnaces have had, and still continue to have, a large amount of attention from practical as well as eminent scientific gentlemen. On a previous occasion I said that, in my opinion, they had not arrived at the summit of perfection; but that, with the amount of intelligence and practical knowledge being that was brought to bear on the subject, they would shortly reach the point which could not be improved upon. You heard last year that I contemplated constructing some furnaces on the Siemens principle, but with some slight modifications thereon. These furnaces have been erected to the extent of 160 retorts; and I think I am in a position to state at the present moment that the result has not been a failure, but has turned out well. The furnaces have given a uniform heat—far more so than the Siemens furnaces erected four years ago. The heat has been uniform from the front to the back of the retorts; and the carbonizing returns are satisfactory. The idea of regenerative furnaces has been carried out by others more nearly associated

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with yourselves than those which I have indicated; and it must be gratifying to this Association that Mr. G. R. Hislop, of Paisley, who has brought out a furnace entirely of his own construction, has been successful in obtaining results which are satisfactory, and that many gas-works have adopted his furnace. This furnace has one particular advantage, and that is economy in its construction. Mr. Hislop does not require to excavate to so great an extent as we have to do with larger settings; and therefore his invention applies more closely to works of moderate size than to those of large extent. Before leaving the retort-house, I would impress upon all of you, and upon all gas managers in this country, the desirability of reducing as much as possible the amount of Sunday labour. Our stokers have not an easy job; and it is our duty, and I consider we are morally bound, to do our very best to give them that day of rest which has been appointed for the purpose. My experience has proved to me that this cannot be done without some expense, in the matter of fractured retorts, owing to the fluctuations of temperature; but we should apply ourselves with the view to the accomplishment of the object I have indicated.

Condensation, Purification, and Leakage.

It has often occurred to me, as it has to everyone in this room, that some definite conclusion should be arrived at as to the effect of excessive condensation upon gas. It is quite true that many of us have experimented and obtained some kind of results in regard to the effect of condensation on the gas manufactured; but it has not yet been tabulated in any kind of satisfactory form. I am under the impression that the Research Fund of the North British Association of Gas Managers ought to be expended to some extent upon making an inquiry of this kind. An inquiry such as that suggested, I believe, would not only add very materially and valuably to the science of gas making, but would add very much to the knowledge of the members of our profession. In my opinion, also, it is obvious that many of the heavy hydrocarbons which at present pass along with the tar ought to be converted into the light-giving properties of gas. It is only by research that this can be confirmed or contradicted; and I hope some future day to bring the matter before another body of gas engineers, and suggest the desirability of taking the matter up for full investigation.

The purification of gas in closed vessels is still occupying the attention and the research of practical engineers; and I have the idea that the day is not far distant when the changing of a purifier will be less common, and far less frequent, than at present. Much attention is, I understand, being given over the whole country to

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Professor Wanklyn's process of purifying by oxide, and admitting a certain portion of air to do away with the necessity of revivifying the material so frequently as we must do at present. Much can be said in favour of this process, and arguments can be used against it; but I would impress upon every one of you to investigate for yourselves. Do not take to any process which has merely been advocated in print. Experiment and inquire carefully, and adopt the results of your own experience.

One very important item in the distribution of gas is the leakage, or unaccounted-for gas. I cannot use words too strong to impress upon you the desirability of reducing this amount. But there may be one or two points which have not been adopted by everyone present, and which certainly cannot do any harm to be named. In the works over which I am placed, we have strenuously endeavoured to lower the percentage of unaccounted-for gas. I might refer to two or three of these efforts. Every winter, for some years, we have organized squads of men whose duty it was to go and examine all the manholes and the drains in the public streets, as well as all the squares, closes, and alleys, and to report if they have discovered any escapes of gas. It is wonderful the number that have been detected by this process. Then in the country districts we pierce the roads in the vicinity of the mains; and by this means have also discovered many escapes. The question of unaccounted-for gas is very important to every company; and each cubic foot of gas that can be saved by such examinations or research certainly is one cubic foot gained.

Accuracy of Meters.

On a previous occasion I referred to the fact that the registration of gas by meters, as at present issued, is not at all satisfactory. It is quite true these meters are stamped by Government, and sent out as legal measures; but I have shown more than once that the existing system of stamping meters is not by any means satisfactory. Take a wet meter, for example. The Government certify the capacity of the drum or cylinder; but it does not certify the correctness of the index. Then, if you have a correct drum and incorrect index, that meter certainly cannot be a legal measure. The cylinder may be perfectly correct, the capacity may be exactly arrived at; but if the cylinder is connected with an index that is not correct, then the registration of the gas consumed cannot be accurate. In my opinion, the Government ought to ascertain and certify not only the correctness of the cylinder, but the index; and this, I am led to believe, is about to be accomplished.

Improved Value of Residuals.

Now, gentlemen, at a meeting of this kind, I do not think it is desirable or necessary for the Chairman to make a long speech.

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Far more benefit is to be derived from a general, all-round discussion than from any remarks which the Chairman can make; and therefore I would bring my few remarks to a close. Before doing so, however, permit me to say how pleased I am that the value of secondary products has improved during the past year. In the beginning of last year, naphtha, yielding 20 per cent. at 248° Fahr., was realizing about 11d. or 1s. per gallon—nearly double what it would have done twelve months before. Sulphate of ammonia also has maintained an improved price; and a decided advance upon what could have been realized during the preceding year. Let us hope that this will continue; also that the trade of the country, which shows some improvement, will not only maintain its present position, but will advance; and that the dull times over which we have lamented so much are passed, and that there shall be work for the labourer, and profit for the capitalist.

The Salford Scandal and Commissions.

Before I resume my seat, allow me to refer to a matter which gives not only me, but every one of you great pain. I refer to the recent Salford scandal. The remarks made by certain journals that the scandals brought to light in Salford applied equally to all of us, and all gas engineers, must have struck everyone in a very forcible way. Such an insinuation I am quite sure you will righteously repudiate. It may have been the case that one of our brothers has followed a wrong course in the execution of his duties; but there is no reason why the same mantle should fall on all our shoulders. I personally—and I am sure you will all sympathize with me—say that it should not, and does not apply to the gas profession as a whole. I refer to such a subject as this, because it applies so generally; and I consider it my duty to give you my sympathy, and to repudiate the accusation with the greatest indignation which proper words can bring to bear upon the subject. Gentlemen, let us resolve to continue in our hitherto adopted course—to follow that which is right, and to carry out our work in such a manner that not only will our conscience approve, but the world generally will say that we are doing what is right.

I have only now to thank you for the kind attention you have given to my remarks, and to express the hope that the discussion that will follow will be not only pleasant but beneficial.

Mr. A. MacPherson (Kirkcaldy) moved a vote of thanks to the Chairman for his interesting and valuable address. Referring to the regenerative furnaces in use at the Dundee Gas-Works, he said he was pleased to learn that the new adaptation had proved to be a success. Mr. M'Crae had proceeded upon new lines, and had left the well-beaten tracks; and the result reflected very great credit

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upon him, especially as the new adaptation had been approved of by Mr. Frederick Siemens. He referred briefly to the experience of his own men at the Kirkcaldy Gas-Works with the regenerative system of firing; the stokers as well as the foremen being satisfied. He also expressed his pleasure at the success of Mr. Hislop's method of carrying out the modified regenerative system, which he (the speaker) regarded as being specially suitable for small gas-works. On the question of Sunday labour, he urged that the workmen, if they were relieved of all Sunday labour, should not look for the pay given for a seven-days week; and he regarded the matter as being very much one of wages, so far as the men were concerned. There was also to be considered the fact that if retorts were laid off for twelve hours on the Sunday, they were very liable to give way. He appealed to the makers of retorts to study the composition of their clays, so that the retorts might be let down for twelve, or even twenty-four hours, without the risk of damage from doing so. As to leakage, or unaccounted-for gas, he said that this was a matter involving a number of qualifying circumstances —such as the kind of soil through which the gas-mains were laid, whether or not it was a mining district, the length of the mains, &c. There were some gas-works where the station meters were too small for the correct measurement of the amount of gas passed through them; and he referred to a case in which the unaccounted-for gas rose from 9 to 17 per cent. by the adoption of a larger station meter. Dealing with the question of consumers' meters, he said the fact that a meter was stamped by the Government established the legality of it. But he admitted that, although it might be a legal measure, it was not necessarily a just one; and he expressed himself in favour of having meter indexes tested and stamped as well as the drums. He knew that some makers of meters in Scotland were doing what he had recommended. As to secondary products, and their improved values, he hoped that a reduction in the price of gas might be the result, and that consumers would thereby participate in the benefit.

Mr. R. Robertson (Bathgate), speaking on the subject of regenerative furnaces, remarked that the question that was now of much importance was, What was to be done with small gas-works; how was the regenerative system to be applied to them? This was a topic on which two papers had been read at the last meeting of the North British Association of Gas Managers.* Three years ago, he had adopted Mr. Hislop's regenerator furnace, which was now undergoing re-construction. The oven he believed would be far superior to what it was at first; and he felt certain that it would be successful.

* See "Reports of Gas Association" for 1887, pp. 174, 181.

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Mr. W. MACKENZIE (Dunfermline) pointed out the desirability of knowing what was the percentage of gain by the use of the Siemens system.

The CHAIRMAN remarked that, while he was formerly making from 6000 to 7000 cubic feet of gas per mouthpiece per 24 hours, he was now getting close upon 9000 cubic feet.

Mr. MACPHERSON considered that in his case the adoption of the Siemens system had led to the increase of his make of gas from 8000 to 10,000 cubic feet per mouthpiece per 24 hours. There was also the great saving of wages; and, indeed, there was a marked economy all round.

Mr. W. BRODIE (Paisley), referring to the question of unaccounted-for gas, considered that, whether it was high or low, gas managers should deem it desirable to be constantly on the look-out for leakages.

Mr. D. ROBERTSON (Dunoon) said that, with regard to certain remarks of Mr. MacPherson on the subject of leakage, he thought it was not a fair comparison to put the leakage of one town against that of another, because the situations of the towns or districts might be totally different from each other. In a country town having a make of 11½ million cubic feet per annum, and 18 miles of piping, the percentage of leakage was bound to be higher than in a town that was more closely built. For instance, he had a line of piping three miles in length; and the annual revenue derived from the gas consumed out of it did not exceed £60, as the houses, in many cases, were only occupied about three months in the summer time. Another source of loss was the long stretch of service-pipes to each house, which was in many cases at least 100 yards in length; and as it was in private grounds, there was no authority for piercing in order to detect escapes of gas. In such cases, it would, he thought, be advisable to place the meter at or near the entrance gate. The inhabitants of some of the streets in Glasgow, even short ones, would consume as much gas as such works as his own were capable of producing.

Mr. A. YUILL (Alloa) referred to the difficulty of adopting the Siemens regenerative system in its entirety in small works, and especially in such situations as his own, considering that it was necessary to go down so very low for the foundations. In his case, the position selected for a new bench of retorts was such that when the excavation was made, it rapidly filled with water. He had adopted a modification of the Siemens system, but had not obtained such good results as Mr. MacPherson had mentioned. He considered, however, that he was likely to get yet better returns from another bench of retorts.

Mr. MACPHERSON observed that, as to the very watery site of

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Mr. Yuill's foundations, if a bed of concrete were put in for the benches to be built upon, there would be no difficulty. His own experience at Kirkcaldy was of a very different character. His works were over old coal workings, near the surface; and there was no solid foundation.

Mr. J. MACNAIR (Wishaw) referred to the experience gained at Barrhead and Inverness with his simple form of regenerator settings; and he stated that he was about to erect a new oven on this system at the Wishaw Gas-Works.

Mr. ALEX. BROWN (Lanark), speaking on the question of Sunday labour, said there was never an hour of it in his works.

Mr. M'GILCHRIST (Dumbarton) seconded the vote of thanks to the Chairman, proposed by Mr. MacPherson. Proceeding to refer to the matters that had been dealt with in the opening address, and by the speakers in the discussion, he said he was glad to learn of Mr. M'Crae's great success in his retort-settings; and as to the question of condensation in gas-works, he regretted that the Young and Aitken system had not had a fair chance of showing its value. Referring to the good advice of the Chairman regarding leakage, and to Mr. Robertson's remarks on the same subject, he said that it was not desirable that any "Tom, Dick, or Harry" should be allowed to lay service-pipes. He would place restrictions upon them, with the view of making sure that the work was thoroughly well done, so as to prevent waste from leakage. As to meter indices, he held, with other speakers, that something should be done to save the possibility of error arising. On the question of gas residuals, he also made a few remarks; and as to other illuminants, he considered that gas managers had more to fear from paraffin oil than from electricity—a matter to which he had alluded so far back as the year 1877.

Some remarks were subsequently made by Mr. D. M. NELSON (of Glasgow) and by Mr. RENFREW (of Langbank); and the discussion on the matters dealt with in the opening address was brought to a close.

The following matters next occupied attention :—

RETORTS AND DEPOSITED CARBON.

Mr. J. B. TERRACE (Brechin) initiated a short discussion on the subject of an improved form of gas-retort he had devised for the purpose of reducing the tendency of carbon to deposit within the retort. This new form of retort has been in use at Brechin Gas-Works during the past seven or eight months. The retort is slightly contracted at the back end; the angles being considerably altered from the ordinary right angles, and thereby allowing the

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deposited carbon, according to Mr. Terrace, to free itself easily and come away whole when the retort is being cleaned. In this manner, he does away with the great trouble of cutting the carbon in two or more pieces. He claimed as an advantage for his retort that the clearing out of the deposited carbon is no longer attended with prolonged labour and broken retorts; and this, he says, has been borne out by practical experience.*

Mr. M'GILCHRIST remarked that he was not much troubled with deposited carbon in his retorts; but he was satisfied that Mr. Terrace was labouring in the right direction.

Mr. MACPHERSON did not consider there was anything novel in tapered or bevelled retorts; for they had been known at least 20 years. Like the previous speaker, he was not much troubled with deposits of carbon in his retorts.

Mr. PETER HURLL (of the Glenboig Fire-Clay Works) spoke of the difficulties which the makers of retorts experienced in connection with the sizes of the same, and with the sizes and forms of their mouthpieces. In winter, they were practically without work of any kind to do; and in the spring came such a rush of orders that the makers did not get fair play. He narrated some interesting experience gained with reference to fire-clay retorts, more especially upon the question of glazing their interiors, as suggested many years ago by Mr. Ritchie, a Glasgow gas engineer, for the purpose of lessening the hold of deposited carbon within the retort. Then on the subject of tapered retorts, such as Mr. Terrace had spoken of, he said that they were in use in Edinburgh fifteen or twenty years ago.

GAS MAKING FROM OIL.

Mr. ROBERTSON (Bathgate), at the request of the Chairman, made a few remarks on the question of manufacturing gas from mineral oil. Referring to an article which appeared in a Glasgow evening paper the previous week (the leading points of which he briefly summarized), he mentioned that one of his own Directors, under the influence of some of the allegations contained in the article, urged that oil was the proper source from which to manufacture illuminating gas. Mr. Robertson stated to the meeting that he had no positive particulars to impart, and that he was himself desirous of obtaining information.

The CHAIRMAN stated that he and Mr. MacPherson had been Jurors in the Gas Section of the Edinburgh Exhibition, where the oil-gas apparatus referred to in the Glasgow newspaper had been shown in operation. He and his fellow-juror did not report at all favourably on the apparatus.

* See references to this matter in the *Journal of Gas Lighting*, Vol. LI., pp. 465, 516.

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Mr. MACPHERSON spoke at some length on this subject, referring in the first place to the correspondence which appeared in the *Glasgow Herald* last year. He had himself taken part in that correspondence, and had been taken severely to task by Mr. Paterson, of the Patent Paraffin-Oil Gas Lighting Company, for the manner in which he had spoken of the gas, as the result of a visit paid to the gas-works at Colinsburgh, Fifeshire, where the Company's process was then in operation. It had been stated that the gas did not require any purification. But he had found from his own testing of the gas, both at the Edinburgh Exhibition and at the Colinsburgh Gas-Works, that it was highly impure; the presence of sulphuretted hydrogen being easily demonstrated by acetate of lead test-papers. He then read a letter which he had received from Dr. Wallace during the time the correspondence was in progress; this gentleman having given a testimonial regarding the purity of the gas as made by the Oil-Gas Lighting Company. From the tenour of the letter, it almost seemed as if Dr. Wallace had not tested the gas for its purity, or that he had examined gas which had been made from refined burning oil, and which from its nature was assumed to contain no sulphur whatever, from which sulphuretted hydrogen could be obtained as an ingredient of the gas. Such burning oil would cost 5d. or 6d. per gallon; whereas the oil used in making the gas in practical work was set down at 2½d. per gallon.

Mr. MACKENZIE stated that he had carried out a few experiments in the way of making gas from "blue" oil, the cost of which was about 3d. per gallon; but he had never yet been able to detect any sulphuretted hydrogen in the gas so made. He had concluded that it was not profitable to use such oil in the manufacture of illuminating gas.

The CHAIRMAN, concluding the discussion, bore out the remarks of Mr. Macpherson as to the gas spoken of being foul with sulphuretted hydrogen; and he urged upon the gentlemen present to "give the cold shoulder" to the process. Paraffin oil, he said, was their severest competitor.

Mr. Mackenzie having been nominated to preside over next year's gathering, a cordial vote of thanks was passed to Mr. M'Crae for his conduct in the chair and the proceedings terminated.

Later in the afternoon, the annual dinner took place in the same hotel. Mr. M'Crae again presided; the vice-chairs being filled by Mr. Mackenzie and Mr. Macpherson.

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NORTH OF ENGLAND DISTRICT ASSOCIATION.

HALF-YEARLY MEETING, APRIL 28.

This Meeting was held at the Offices of the Newcastle and Gateshead Gas Company, Grainger Street West, Newcastle-on-Tyne—Mr. V. WYATT (the President) in the chair.

The statement of accounts for the year having been adopted,

Mr. J. B. Simpson, mining engineer and colliery-owner, of Newcastle, and Mr. R. Seymour Benson, of Messrs. Ashmore, Benson, Pease, and Co., Limited, of Stockton, were admitted Associates.

The PRESIDENT then read the following paper, mainly explanatory of his address to the Association at their previous meeting (October, 1887*).

THE STRUCTURAL CAPACITY AND COST OF GAS-WORKS.

The details of my paper of October last were applicable to gas-works with a production of not less than 5 million cubic feet of gas per diem—taking an average December day. This would be apparent by the sketch plan of the works attached to the paper, and which was given as the standard for working out the figures. Supposing I wished to apply the table to a smaller standard of works than this, so far as money value and capital expenditure are concerned, I should add 10 per cent. to the cost of the plant for each million cubic feet per diem of diminished production less than 5 millions, on the ton of coals carbonized per year. Thus, for works carbonizing only sufficient coal for a yield of 1 million instead of 5 million cubic feet of gas per diem, I should put the capital expenditure at £5 per ton of coals carbonized per year, instead of, as in the table attached to the paper, at £3·54. This principle of smaller works costing more than larger ones is recognized later on in the paper, where the first section of the works is priced out at £4·72 per ton per year.

I also assumed in the paper that it is possible and advisable to wipe away the bogus and unreal capital (that which is a myth on the accounts, and has nothing at the back of it) from gas undertakings, by gradually reducing the nominal capital to a real thing

* See "Reports of Gas Associations for 1887," p. 225.

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—the structural value of the works and properties; and corrected from time to time (say, at intervals of five years) to suit changing values and conditions.

Also I assumed that, with coals at a cost not exceeding 12s. per ton laid down in the retort-house, and with residuals returning half this amount, 16-candle gas should be sold net to the consumer at 2s. per 1000 cubic feet, with a free meter, and a service-pipe laid gratis to the external wall of each tenement. There are several gas-works at the present time manufacturing this quality of gas, where 12s. and under per ton is paid for coals, at a net cost within 1s. 6d. per 1000 cubic feet on the sold gas. This gas sold at 2s. would allow of 6d. per 1000 cubic feet for dividend and interest, on a true capital of £5 per ton carbonized per year. Some companies show on their accounts a net cost for gas at the consumers' meters of 1s. 4d. per 1000 cubic feet, with coals ranging from 10s. to 12s. per ton.

A badly managed gas company can pay high dividends if it be accommodated by Parliament with a convenient sliding scale standard, even when it puts down in its balance-sheet a big capital. We must, however, recollect that there is a plethora of capital running about the world for investment at 4 per cent. and under; and likewise that statutory gas undertakings have no such perfect monopoly of a district as to claim that no body, person, or persons other than themselves shall under any conditions supply gas within the same locality. It has again and again been stated by legal luminaries, and not contradicted, that anybody is at liberty to acquire land and construct gas-works, at his own will and risk, and sell gas in the same district as an "Act of Parliament" gas company. The "how to do it" is only a question of fighting, means, and enterprise; and "the survival of the fittest." Have we not seen in a moderate-sized town three statutory railway companies, with three lines of railway, all competing for a mere handful of traffic? and this under the solemn sanction of an enlightened Legislature. It has been well said that "the payment of ordinary dividends will win the day in the long run, and ward off opposition." In one of the Metropolitan financial papers for March, it is thus written: "It is only a question of a short period before the London Gas Companies will be able to supply gas at 2s. per 1000 cubic feet." This, be it noted, with dividends at 13 per cent., and coals costing over 12s. per ton.

In the returns of all the gas companies in this country for the five years 1881 to 1886, there is a very good confirmation of the capital expenditure per ton given in my table, and which I had not seen when I prepared the details. For the extra amount of coal carbonized during the five years by the London and Suburban Gas

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Companies over the preceding period, the capital had been increased at the rate of £3·69; and the whole of the companies in the United Kingdom at £3·87 per ton of coals carbonized extra per year. The figures I gave were £3·54 for a large establishment. The figures from the returns include large and small works. I find actually in modern practice that for moderate-sized works (say, to make a million cubic feet per diem) the capital expenditure runs as follows: Manufacturing works and plant, or gas-works proper, £3; distribution works, £1 10s.; floating capital, 10s.; in all equal to £5 per ton of coals carbonized per year.

I would wish to make a few minor corrections to the table appended to my paper; but they will not affect materially the given capital total per ton. Purifiers "cost per cubic foot," 3s. instead of 3s. 2d.; gasholder tanks "capacity of structure per ton," 5500 instead of 5000 cubic feet, and "capacity per 1000 cubic feet," 550 instead of 500 cubic feet, with a "cost per cubic foot" of 2·10d. instead of 2·33d.; gasholders "cost per cubic foot," 1·40d. instead of 1·50d.; workshops and offices "capacity of structure per ton," 370 instead of 1500 cubic feet; and "capacity per 1000 cubic feet," 37 instead of 150 cubic feet. Allowance was not made in the table for the gasholder tanks to have 10 per cent. more capacity than one-half of the gasholder capacity, which is the result where two-lift holders are adopted. These corrections mostly refer to small clerical errors in not carrying out the decimals; and they do not affect the "ultimate cost" figures.

The items of tanks and gasholders in the schedule are estimated from examples for an available storeage of 2 million cubic feet, qualified by improved lines of construction, the present prices of materials and labour, and assumed to be built under average conditions. The method of construction usually adopted for tanks is capable of improvement, which, had I the time at my disposal, I could explain to you in detail. I hope to do this at some future time. Suffice to say, for the present, that the cost of £10·615 per 1000 cubic feet of storeage given in the table is sufficient for a sound tank and holder of that capacity, on a good site, at the prices of materials named. Tanks and gasholders erected twenty years ago cost about £20 per 1000 cubic feet of storeage for the combined structure. But since then the cost of this capital unit has been gradually coming down, until at the present time the value has descended to about one-half. This fact is apparent by an inspection of the payments made for tanks and holders in times past by the leviathan gas companies. There are "evolution," "gradual development," and the "survival of the fittest" in tanks and holders as in other things in creation. Volume of vessel has much to do with cost of construction, as can be seen by the following

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table, computed for sites favourably conditioned, the tanks and holders designed upon the same lines, and at the following rates: Iron fixed complete, £17 per ton; earthwork, 2s. 6d. per cubic yard; brickwork in cement, 26s. per cubic yard; stone (ashlar), 4s. per cubic foot; and concrete, 12s. 6d. per cubic yard.

Capacity. Cubic Feet.	Area of Skin or Sheeting to Crown and Sides, Sup. Ft.	Weight of Holder and Framing. Tons.	Cost per 1000 c. ft. storeage for Holder and Framing.	Cost per 1000 c. ft. of Gas storeage for Tank.	Cost per 1000 c. ft. Gas Storeage, Holder and Tank.	Weight of Iron in Struct. per 1000 c. ft. storeage.
			£ s. d.	£ s. d.	£ s. d.	Cwt.
1 million	47,329	400	7 0 0	5 15 0	12 15 0	8·00
2 „	71,414	670	5 13 10	5 3 0	10 16 10	6·70
3 „	95,726	908	5 3 8	4 10 6	9 13 8	6·05
6 „	148,523	1546	4 4 1	4 0 0	8 4 1	5·15

The area of sheeting or skin is seen to govern the cost of the holders as well as the volume. The best proportion of holder—diameter × height—is that which gives the most volume with the least area of sheeting plates. In the above table the area of sheeting for a 1-million cubic feet is about half that for a 3-million feet holder; and the total tons of iron required for the former approaches half (actually 44 per cent.) that of the large one, although the difference in volume is three times.* You can estimate approximately the cost of a holder and guide-framing by merely regarding the area of sheeting; as the difference of weights in pounds per superficial foot of skin for holders and framing of various volumes is but trifling. Thus these weights in the table for holders and framings of from 1 to 6 millions run from 19 lbs. to 23 lbs.; showing an average of 21 lbs. per superficial foot as the estimating factor. This is quick and ready.

In a "technical" journal exception has been taken to my estimates for tanks and holders, and also that I do not preach what I practice. This, "from a correspondent," was inspired by a former assistant of mine, who uses figures, &c., which he obtained while in a post of confidence, from my private notes and papers, ten years ago. But let it go, except to remark that the conclusions as to cost are answered by what I have previously stated as to time of erection, prices for labour, materials, and so forth. The examples given by my critic run back 20 years. The site could not be paralleled for badness—a hopeless bog; and instead of the wrought-iron costing £17 per ton as now, the rates were £20, £25, and even £32 per ton. The excavation cost double that from an average site; and the puddle cost three times the normal figure—

* Comparing 1 million with 6 millions, where the difference of capacity s six times, the increase of iron is less than four times.

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an article, by-the-by, which is now usually dispensed with. Then to get in the bottoms, water was pumped against a head of 50 feet, in direct communication with a tidal river, at a cost of £1250 per tank; and the holders were erected over and through 40 feet of water in the tanks. In fact, the erectors and divers worked from floating rafts, with their lives in their hands. Amongst my examples for arriving at the estimates given in the table, I did, however, use my experiences relating to the two most recent tanks and holders cited by my critic; these having the same volumes as those in the schedule. But in fixing the cost, I stripped away the abnormal conditions and difficulties alone to be found at Beckton. As a proof of how far iron structures have been cheapened in recent years, take a wrought-iron ship, which, like a gasholder, is a floating vessel, and which cost in 1883 £24,000, while in this present year of grace it can be made of a more refined class of iron, called steel, for £14,000.

To the item of purifiers in the table, I have attached 133 cubic feet of "capacity per ton of coals carbonized per diem." I remarked that some gas companies have as much as 150 cubic feet, but I might have said even as much as 175 cubic feet of space, with 175 superficial feet of sieves. These latter figures, however, are too indulgent; and such capital cost has resulted from fear of official fines, and raising a "hue and cry" against the gas company. Too much space may be given to the pairs of boxes which perform the supplementary duties, in purification, of eliminating the small doses of sulphur compounds, and of checking off the last traces of impurity in the gas. A line of six purifiers on each current of gas would seem, by experience, sufficient to ensure safety, providing the two last purifiers in a series—those used for sulphur compounds and check purposes—were provided with a partition across each box, and covered by twin lids; so that one-half of a purifier could be charged at any time, without cutting off a stage of the purification, and at the same time giving duplicate purifiers for each part of the process.

The petroleum industry is still shooting to the front. Nature is so generous in her supplies that she seems to call continually upon the human intellect to scheme ways and means for the utilization of this great and inexhaustible source of light and heat. We are promised imports of cheap "lumps of delight" in the shape of solidified blocks of mineral oil, with which to produce these necessaries of life—light of from 40 to 60 candle power, almost void (2 per cent. only) of residuals, and odourless; fuel, clean, of intense heat, matchless, and rapid in combustion, no smoke, with a threatened clear-out of the present method of coal carbonization, and a stop to the constantly recurring presence of "King Fog."

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In conclusion, permit me to briefly relate, literally, to you two life portraits, photographed on my memory, bearing upon recent agitations in the gas world, by way of moral. Managerial delinquencies are sometimes tacitly permitted and winked at; sometimes they arise from trade temptation acting on a feeble nature, to whom "necessity has no law." First, as to the permissive form, I once knew a gas undertaking which had a manager who worked on a low salary, which was never raised. He bought all the goods for the concern, and was tacitly privileged to take what he could get by way of "commissions" from the traders. In fact, one of the directors informed me they "winked at 'em"—that is to say, the tips. "They could not do without their manager," he said, "as he (the manager) is of the very essence of the concern; in fact, he hooks a good part of his screw out of the trading chaps." That manager looked happy in his person, carried a portly figure, was eminently charitable. He became ultimately the chief holder of stock (and the best stock too) in the concern; nearly "monarch of all he surveyed;" and I noticed that he always shook hands warmly with his directors. The gas he evolved and sold was fairly dear, and unfairly dim. That manager, like all of us, had to die. His will cut up fat. Then came "chaos and gnashing of teeth;"—but all was done in private. It was then found that the "defunct" might most profitably have been done without. His place was supplied by a model of integrity, and all went "ten per cent." happy afterwards. Second, as to the tempted: I also knew another manager, of another concern, who when he had remitted to him some golden graven images from a wicked trader, he indignantly returned the "filthy lucre" to the place from whence it came. Once he paid the "lucre" into a hospital fund, as "conscience money," where, he said, it cleansed the uneasy soul of his wretched tempter in purgatory. That manager was thin, and thoughtful in his environment; he was a demon at his work; his establishment and plant were as clean, fresh, and bright as new paint; he was "much married," and had a miserably prolific spouse, who kept him square. But still that man's end was peace and a marble slab.

Discussion.

Mr. J. WRIGHT (Stockton-on-Tees) said they would not have much discussion without criticism; but at the same time it was difficult to criticize a paper of such great excellence, from an engineering point of view, as that read by their President. He might at once say that he thought it was one of the most valuable ever read before the Association. It was so brimful of technical information as to the cost of the various appliances used in gas-works, that it must always be a standard for reference by gas

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engineers and members of this and kindred societies. There were very few engineers who, from their own experience, could compile such a series of costs and figures; but there were still fewer who, having the information, would give it for the benefit of professional brethren. Therefore he considered their thanks were due to the President. Whilst saying so much with all sincerity, there was one point on which he thought the paper was rather misleading. Speaking of the possible effects of petroleum, Mr. Wyatt said: "We must not frighten ourselves further on the subject, but make up our minds to produce cheap gas." In this they would all agree with him; but he was surprised to find that one of the most powerful aids in this direction, which most engineers had at hand, was rather tabooed in the paper. He referred to the trebling of gasholders. This aspect of modern engineering certainly did not receive the commendation it deserved; and in his view, was the weak point in the paper—especially where Mr. Wyatt referred to "cranky knock-kneed treble lifts." Now he (Mr. Wright) had yet to see any "crankiness" or "knock-knees" about them, although the Company with which he was connected had at one gas-works alone, trebled six gasholders 120 feet diameter, giving an extra storeage of 1½ million cubic feet. In Newcastle, at the Elswick works, two holders had been treated in the same way, increasing the storeage by 600,000 cubic feet; and the cost in neither case exceeded £10 per 1000 cubic feet. Then the President had a good-natured shot at three-lift holders, on the score of wind pressure. His figures certainly looked formidable; but then they all knew how easy it was to make figures assume any shape. In practice they got over the figures; because in the time of their predecessors, it was the custom to guide the holders with strong round columns, which had such an ample factor of safety when constructed that it was the easiest thing in the world now to lengthen them. He could assure the members of the Association who had gasholders 100 feet in diameter and upwards, with good strong columns or stancheons, that they could be doubled or trebled at a cost of about £10 per 1000 cubic feet capacity gained. Holders of 120 feet and upwards might be changed for a less figure; but much depended on the guide-framing. The method of procedure was to put the new inner lift inside the present holder, by shortening the main bars and lengthening the columns or standards as the case might be; then inserting horizontal girders and diagonal bracing. Now he would like to ask, Who could build (say) a new complete holder and tank to contain 300,000 or 400,000 cubic feet for a less figure than £15 or £16 per 1000 cubic feet? True, their President had told them that a tank and holder of 2 million cubic feet capacity could be built for £10 per 1000 feet. These figures, they should bear in mind, did not

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include the cost of the land, which, in crowded towns where most old gas-works were situated, was a great consideration; and although "cast-iron pipes are cheap enough in these days," they had still to add the cost of these mains—no small item! How many members of the Association, however, were there who required to build at one stroke a gasholder of 2 million cubic feet capacity? What was wanted to assist in making gas cheap was to obtain increased storeage of quantities from ½ to ¼ million feet; and he (Mr. Wright) had shown that, by doubling, trebling, or quadrupling, they could augment their storeage to that extent at £10 or less per 1000 feet, and this without involving the construction of enormous gasholders. In all other respects he considered the paper a most valuable one; and concluded by again thanking the President for reading it.

Mr. W. Ashmore (Stockton-on-Tees) observed that he did not think he could give any information other than Mr. Wright had done. No doubt in small works, such as Mr. Wright had been speaking of, it would be a great advantage for engineers who had two or three gasholders that could be doubled or trebled, because the work could be done in one year. But, if they had to make a tank 180 feet in diameter, it could not be done in a year.

Mr. G. Ridley (Newcastle-on-Tyne) did not think he could add anything to what Mr. Wright had said. There was no doubt that trebled gasholders had been a great acquisition to the Newcastle Company, because it had increased their storeage capacity by a cheap process; and the holders looked strong and firm everywhere. The last one that was completed was 120 feet diameter. In a gale of wind, it used to oscillate 5½ inches; but since it had been trebled, it had been in a gale, and stood as firm as a rock. He thought the trebling of holders was of great advantage where it could be carried out, because it did away with the making of a tank; and there was also a saving of mains and valves.

Mr. T. Bower (West Hartlepool) said he did not know that he had very much to say with regard to the points which had been raised by Mr. Wright. It had not hitherto been his privilege to have anything to do with gasholders which had been erected at such a low figure as that instanced by the President in his paper. Of those he had been connected with, one was of a capacity very near to what he had mentioned—a working capacity of about 900,000 cubic feet. The cost of this holder and tank was rather more than £15 per 1000 cubic feet. Of course, they must bear in mind, in comparing the cost, that it was six years ago when this holder was erected; and he estimated that the difference in price between then and now would bring the figure down to something like £13 per 1000 cubic feet.

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The PRESIDENT: I estimated a gasholder of that capacity at £12 10s.

Mr. BOWER, continuing, said the figure he had stated was the actual cost of this one; but if they went to smaller sizes—and he thought that one of the great points in the paper was the fact of all the apparatus dealt with being altogether beyond the size that was ever likely to be required in the North of England—the facts were somewhat misleading. He had with him estimates from two or three different firms of gasholder makers; and none of them were less than £15 per 1000 cubic feet. This information was obtained some three years ago. If he went lower down in size, to about 60,000 cubic feet—certainly the circumstances were rather exceptional, inasmuch as quicksands had to be dealt with; but he found that the cost ran up to about £24 per 1000 cubic feet. One other matter he wished to refer to was that the difference between the maximum and minimum sizes of works was not sufficiently pointed out. It might have been spread abroad that engineers in the North of England had been very extravagant, whereas it was not so, but was really owing to this: The difference between gas-works capable of producing 6 million feet per day (which were given as the basis of the President's calculations) and works of perhaps half a million feet capacity. If this had been made a little clearer, he thought it would be of advantage to the outside public.

The PRESIDENT observed that, in the table which he submitted with his paper, he stated that, in the same ratio as he adopted, going backwards, between the one and the six million, they would find something like the figures he spoke of. The amount of iron per 1000 cubic feet of storeage in the 1 million feet holder would be 8 cwt.; and in the larger size it would be only 5¾ cwt. By this they would see how the weight had decreased. If they worked backwards in the same ratio, they would come to increasing instead of diminishing figures. But they would observe that in the one case there was a decrease to little more than one-half per 1000 feet of storeage which the other would cost.

Mr. C. SELLERS (York) said, as far as he could gather, they were contending for a principle which it would be very difficult to fix, because, to arrive at the cost of a holder, much would depend on the circumstances in each case. First, it would depend upon the cost of the land; and the tank would depend upon the nature of the soil. As their President knew, the site upon which the last new holder at York was placed cost them considerably more than any average tank would have cost, in consequence of the nature of the soil. They were pumping water out of the excavation for nearly two years. But, in addition to the character of the soil,

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which very much affected the construction of a holder, he found that, from one year to another, there was a great variation in the cost of iron. Middlesbrough pig iron was now, he believed, something like 32s. per ton; and a few years ago it was 120s. per ton. Therefore this fact alone would considerably modify any attempt at fixing a rule to be applied at all times. Consequently, he did not himself see the worth of attempting to lay down any rigid lines of cost for either a gasholder or a tank.

Mr. W. Ford (Stockton) remarked that he was sorry to say he could add little or nothing which would be of use with regard to the question of the structural cost of works. His experience had been in the construction of works of a certain size; and he understood that the President's figures were rather taken from a large point of view, which, he was afraid, could hardly be adopted by managers of works of the same size as his. Therefore, to compare their prices with those cited, where millions of cubic feet of gas were made, would be misleading to men in Newcastle and the North of England. The works which they had to preside over were very small; and he felt he could not enter into a discussion upon the matter with any satisfaction to himself, or with the hope of being of any benefit to the members. With regard to the question of trebling gasholders, his experience was that this course was really cheaper at the time than constructing a new holder; and, so far, he had found no disadvantage at all in having trebled his 150 feet holder. He did not know the saving in cost; but it must have been an enormous benefit to them.

The President, in replying on the discussion, said that when he was framing the table which he had submitted, it was very evident what he was doing, because he gave a sketch plan of the works, which strictly defined the view upon which it was prepared; and he said, moreover, that they could make the table equally useful for large or small works by working percentages. He had said again that day that if they were to manufacture 5 or 1 million cubic feet per day, the difference would be such that it would be quite easy to make the calculation; and they could descend in the same ratio, still making the table equally serviceable. He himself frequently used it, both as to ratio and actual cost. He considered that they must have a standard, like a sliding scale, and that they must work above and below it. Keeping this in view, they would find it about as useful for 1 as for 5 millions; but only that they had a better range in the larger works. Mr. Wright had complained of the use of the term "cranky" with reference to three-lift gasholders. His reason for using the word was simply this, that the middle lift of a three-lift holder has a very confined space to put in posts to stand upon when it was down on its bearings. All posts

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should have a diameter about one-fortieth of their height; and, he asked, Could they have that in a middle lift? If they had not, the duration of the iron in the posts would be affected. There were some posts in the middle lifts which had a very small margin of safety. He would not say how small; but they did not stand upright on their bearings. In speaking of the cost of gasholders, he merely took the price of the structure. Supposing they had no room for extensions, and they had to provide for from 1 to 3 million cubic feet, by all means telescope the holders. They would see, by the figures which he gave them, that, by adding in the proper proportions, the two-lift beat the three-lift holder. Why was this? It was only because they had the proper proportions; they had the least shell, which was the most important circumstance. The gasholder which had the least proportion of skin was the best, because the difference in price between the large and the small holder was a small factor of pounds per foot of skin. He did not say that a three-lift gasholder was not absolutely safe, neither did he say that under certain conditions it would not be the safest. But he said that in two lifts, up to 6 million cubic feet, was the cheapest way to build a gasholder, because it had the smallest number of parts in it, was the strongest, had the smallest number of rollers to oil, and was the best in every way. When they spoke of three lifts, they could only go a certain height; there was a limit, which must be, and which was easily defined. It did not matter where they began, whether it was for 2 or 5 millions, they must increase in price as they decreased in volume. It had been mentioned that a million feet gasholder would cost from £13 to £15 per 1000 cubic feet. Of course, in reckoning up this, they must take the same price for materials as he did; but, applying like conditions to his, he made the cost £12 10s., whereas in the table it amounted to £16 10s. 4d. They saw the difference by going higher or lower in volume. It simply rose, as he had shown, in the proportion of one in six; and so it was very easy to apply this table to any gasholder. Mr. Sellers referred to land; but he was not, of course, including the price of land. He, however, did embrace pumping, which Mr. Sellers mentioned, and which was a very considerable item. Where water came in largely, something would have to be added for it. But he was not speaking of what they would call even a good average site, because, at Beckton, they required to pump against a tidal river with 50 feet of water; and they had to use most powerful pumps. This was abnormal. In the case which Mr. Sellers mentioned, it was very different. But still he himself, though he had heavy pumping, did not get to a very big figure. Mr. Ford spoke of the proportional cost of gas-works; but they would observe that he (the President)

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would, in the instance alluded to by Mr. Ford, use a very much smaller scale. He thought he stated in his supplementary paper that day (and he also alluded to it in the original communication), that if they took a 5 million cubic feet gas-works at £3·54 per ton per annum, the million feet works would cost £5 per ton. Working in the same ratio, he believed they would be very near the mark. But, of course, in making all these calculations, they had to take into account the average prices they would have to pay for materials and the cost of the work.

Mr. W. HARDIE (Newcastle-on-Tyne) said he thought they were very much indebted to their President for the excellent paper which he gave them last October, and also for his communication that day, explanatory of some points on which criticism had been raised in the interval. The first paper had excited a good deal of interest, not only in this country, but in other countries; and the *Journal de l'Eclairage au Gaz* gave a translation of it, and also commended it to the study of gas engineers. He begged to propose a hearty vote of thanks to their President.

Mr. FORD had great pleasure in seconding Mr. Hardie's proposal; believing as he did that a clearer exposition of gas engineering had never been given than that which the President had put before them.

The motion having been agreed to,

The PRESIDENT, in acknowledging the compliment, said he was severely castigated for the information he had given them. But he did not think there was any harm in imparting information; for if they did not give it themselves, it would be taken out of them, and be made to walk before them in other clothes. He had sought, throughout his paper, to give information which would not be inapplicable to any circumstances. He did not require special conditions to be laid down. There was no use taking a certain tank or gasholder; they should take a good average standard, and work upon it. He was very much obliged to the members for their kind remarks; and he hoped some time to prove satisfactorily to them that a tank and gasholder could, in all its *minutiæ*, be constructed, under what might be called decent average conditions, for the price he had named, working above or below that standard.

Mr. A. C. WILSON, F.C.S. (Stockton), then read the second instalment of the paper presented by him at a previous meeting*; the subject of the present communication being

COAL: ITS ORIGIN AND VALUATION AS A GAS PRODUCER.

Leaving for a few minutes all troublesome and intruding

* See "Reports of Gas Associations for 1887," p. 252.

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thoughts of our busy nineteenth-century life, with its daily round of work, excitement, pleasure, and the hundred-and-one little things which constitute our struggle for existence, let us glance far into the distant past—to that remote period in this world's history when the whole of the area now recognized as the Northumberland and Durham coal-field was one vast and luxuriant forest, composed of ferns and coniferous trees, providing shelter and food for numbers of amphibious reptiles, together with swarms of small insects. Here grew the noble lepidodendri—that giant representative of our modest little club-mosses—to a height of 50 feet, and still shaded from the scorching rays of the sun by the yet more majestic sigillaria, which, with its roots fixed firmly in the ancient soil on which this rich vegetation flourished with such luxuriance, was able to raise its graceful head to a height exceeding 70 feet, drinking in the moisture and absorbing from the sun's rays that energy which we now utilize, and which has played, is playing, and will continue to play, such an important part in civilized life. In no other age did the world ever witness such a gorgeous and prolific flora as was seen in the forests of the carboniferous period. It was indeed the age of plants; over 800 distinct varieties having been recognized in the coal measures of this country.

Very beautiful must the earth have appeared, with its bright green carpet of soft and delicate ferns, rich mosses, and majestic trees. Warmed and strengthened by the rays of the sun, tropical in their intensity, nourished by the rich water-laden soil and moisture-laden air, generation after generation of plant life flourished and decayed, depositing each successive year fresh portions of rich vegetable matter. We see in each stratum a volume carefully written by Nature herself, and containing the history of, it may be, many thousands of years. If we could only open the pages—the strange contents—what an interesting story we should hear. The carboniferous period was indeed a most beautiful picture of Nature; and we might be forgiven if we looked to that period for the Golden Age when strife and bloodshed was unknown, and all was happiness, peace, and love. But, alas! no. Ever since animal life began to exist on our little planet, there always has been, is still, and in all probability always will be, a constant struggle—the strong living on the weak. In all orders there have lived, and are still living, carnivorous classes which could not live except by the death of their neighbours, and who possess Nature's armament for the taking of their neighbour's life, just as our butcher with his knife, or the sportsman with his gun. One thing, however, is certain, that there were periods in the history of the past when the weapons assumed a more formidable aspect than at others; and never were they more formidable than during the

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formation of the carboniferous coal deposits. As we should expect, just as the weapons for destruction became from time to time more deadly and destructive, so the defensive armour of the animals preyed upon must have become more remarkable for their powers of resistance.

The land upon which this luxuriant vegetation flourished was very slightly above the level of the sea; and it is most probable that during the formation of these organic deposits the surface was gradually sinking. As might be expected under the circumstances, the waters of the lakes and rivers frequently overflowed their banks, and deposited on the land a thin covering of sandy and earthy matter; and this, I think, is an explanation for the thin films of sandy matter we notice in the coals of this district. But this sinking or lowering of the earth's crust appears to have taken place more rapidly, and sunk to a greater depth at times; for we have every sign that the waters must have rolled over the organic deposit for a considerable period, forming over it a strata of sand and mud. Then there comes another change; the bed begins to rise again, and soon we find traces of amphibians having sported themselves in the shallow and soft mud. A further drying takes place, and the earth once more brings forth another vast and luxuriant growth of vegetation, which, in the course of ages, deposits another stratum of vegetable matter; and this goes on till the carboniferous deposits of the palæozoic period, with their vast stores of latent energy, are completed, and the appearance of the lower new red sandstone marks the beginning of the permean period.

The conversion of this vast mass of vegetable matter into coal has been the work of ages; but the exact causes, chemical and physical, which have brought about this change are unknown. It is probable, however, that the first change would be the loss of moisture and the fermentation of albuminous matter and gum. This would bring about a molecular change; there would be a rise in temperature, but an absence of a supply of air would arrest too rapid carbonization. The mass at this time would, no doubt, be subjected to great pressure. The oxygen and hydrogen, being most subject to the effect of this metamorphosis—these elements leaving the carbon—would more readily assume their simplest and more permanent state of combination. But conditions of temperature and pressure complicate the reaction, the result being that carbonic acid gas and hydrocarbons of the marsh-gas series are formed; leaving an accumulation of carbon and mineral matter in the residue.

For the sake of example, cellulose, which constitutes the bulk of woody fibre (the substance of which the vegetable deposits were

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chiefly composed), might be expected to decompose according to the following equation:—

$$2\,C_6H_{10}O_5 = 5\,CH_4 + 5\,CO_2 + C_2.$$

Cellulose. Marsh gas. Carb. acid gas. Carbon.

The occurrence of marsh gas and petroleum hydrocarbons of similar compositions, together with carbonic acid gas, in connection with the working of coal deposits, bears out, I think, this account of its formation.

As we might expect from a study of its origin, coal is not a homogeneous substance, but a mixture of substances—anthracite, bitumen, and mineral. Of these the earthy and pyriteous may be regarded as being the most objectionable. It is obvious also that as coal is the result of chemical reaction in peat, or that which is practically the same, if that action has not been the same throughout the whole mass of the deposit, then the resulting coal will vary in composition. This variation may be small, or it may be great. Or it may be that results have been made more complicated by the changing of a portion of the strata by the bursting through of igneous rock in the molten condition, as, for example, the 90-fathom dyke, which so many colliery-owners in Durham regard with such tender affection. Coal, therefore, may be said to vary according to the decomposition which it has undergone, the physical conditions under which the changes took place, and the amount of foreign matter present.

The three principle varieties of coal—lignite, bituminous coal, and anthracite—give us examples of the material in different stages of carbonization or decomposition. The lignite or brown coal, belonging to more recent formations, is found in tertiary deposits; the Bovey coal of Devonshire being a good example. As a rule, this class of coal is of brown colour; showing a distinct woody structure, is brittle, devoid of lustre, and burns readily, leaving a white ash. There are several other varieties; but it is hardly worth while occupying your time with a description of them, as they are not used as gas producers. Of the bituminous coals there are several varieties; and as they are the source from which coal gas is generally prepared, it will be well to notice, in a passing manner, some of the most important members of this class.

They are generally found in secondary formations; the most marked varieties being caking coal, splint coal, cherry coal, and cannel coal. Of these caking coal is most used as a gas producer. It is found in almost all of our English coal-fields; but the Northumberland and Durham coal-fields are most noted for it. This variety of coal is moderately compact; with a lustre varying from a resinous to a velvety or greyish black appearance. It splits

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up on heating; and afterwards forms a compact mass—the higher the proportion of bitumen, the more marked is the fusion. Splint coal is abundant in the deposits near Glasgow; its colour varies from black to a brownish black.

Cherry coal is very similar in appearance to caking coal. It is, however, more brittle, and does not fuse when heated. It is found in the upper strata of the Glasgow beds, and also in the Staffordshire and Lancashire district.

Cannel coal is sometimes spoken of as candle, or parrot coal—the former on account of the readiness with which it burns; the latter because the constant crackling it makes while burning is suggestive of that proverbially noisy bird the parrot. It is compact, with an even texture, a shining resinous lustre, and a colour varying between jet and a greyish or brownish black. It is found in Scotland, Lancashire, Warwickshire, and North Wales, and is much used as a gas producer; the gas being plentiful, and of high illuminating power. As a rule, cannel coals contain a large amount of earthy matter. The following is an analysis of a very rich Boghead coal—made by Dr. Penny, of Glasgow :—

	Per Cent.
Fixed carbon	11·30
Ash	16·80
Sulphur	0·34
Water	0·60
Volatile matters	71·30

The coke resulting from the carbonization of this cannel alone would contain 40·28 per cent. of ash, and would consequently be of little or no value. Many cannels, however, contain a much larger percentage of ash; and may almost be regarded as shales.

Anthracite belongs to the oldest coal formations. In its purer forms, it consists of little else than carbon, water, and mineral matter. In this form, it represents the last stage of the coal-forming process. The majority of the anthracites contain at least a small proportion of bituminous matter. They are the dearest of all known coals, and possess a very high degree of lustre. Large deposits are being worked in America; and it is also found and worked in the South Wales coal-field. The following are the results of an analysis of Welsh anthracite :—

	Per Cent.
Fixed carbon	89·84
Ash	1·20
Sulphur	0·80
Moisture	2·25
Volatile matter	6·01

The coals in which we are most interested belong to the bituminous class, of which cannel and caking coals may be regarded as being by far the most important members. They may be said

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to consist of anthracite, bitumen, and earthy matter. It has been stated by some writers that all coals rich in the elements producing a plentiful supply of highly illuminating gas, abound with translucent brownish cells and resinous pores of plants of the club-moss order.

The value of a coal or cannel as a gas producer is determined by the following particulars:—(1) The quantity of gas it will yield, and the freedom of such gas from sulphur compounds, carbonic oxide, carbonic acid, and other impurities. (2) The illuminating power of the gas. (3) The quantity and quality of the coke, and its freedom from earthy matter. (4) The quality and strength of the ammoniacal liquor produced. (5) The quantity and quality of tar. Much information relative to the suitability of a coal for the purpose of gas making may be derived from an elementary analysis of the coal; the most important point being the unoxidized hydrogen on which the yield of coal gas depends. The following are the results of an elementary analysis of Newcastle coal:—

	Per Cent.
Carbon	86·81
Hydrogen	4·96
Nitrogen	1·05
Sulphur	0·88
Oxygen	5·22
Ash	1·08
	Per Cent.
Coke	72·19
Gas	17·24
Unoxidized hydrogen	4·31

This form of analysis is often very confusing; and since the value of a coal as a gas producer depends upon the amount of volatile matter which it will yield on carbonization, I consider that the following form of analysis gives the gas engineer a much better idea as to its suitability than an ultimate analysis would:—

	Trimdon. Per Cent.		Hutton Henry. Per Cent.
Fixed carbon	61·11	..	61·40
Ash	4·06	..	4·70
Sulphur	0·83	..	0·93
Moisture	1·70	..	1·30
Volatile matter	32·30	..	31·67
	Per Cent.		Per Cent.
Yield of gas per ton	10,583		10,320

Additional information may be given, as, for example, the illuminating power of the gas, the yield of coke per ton of coal.

In the carbonization of coal, as in every other art, experience is

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the best guide. The information contained in an analysis such as I have referred to of the coal supplied, must be of considerable assistance, inasmuch as it shows at a glance the quality of the coal, the quantity of gas which it may be expected to yield on good carbonization, the amount of sulphur compounds likely to be present, and the quantity of coke and amount of ash which it will contain. As the coals vary in composition, even when taken from the same seam, it is advisable to have at least the ash and volatile matters estimated frequently.

In conclusion, I may say that bituminous coals lose gas by being exposed to a moist atmosphere, and that small coal does not yield as much, or as rich a gas, as large coal of the same class would.

Discussion.

The PRESIDENT, in opening the proceedings, said they had listened to a very interesting paper, historically and practically, upon coal.

Mr. H. M'GILLIVRAY (Walker-on-Tyne), alluding to the remarks as to coal being frequently tested to ascertain the amount of volatile matter and ash present, he said that in his own experience he had met with certain coal, not very far from Newcastle, which he had known in one week to vary nearly 25 per cent. in volatile matter and ash; and this, too, in samples taken from the same seam. This, he considered, could only be accounted for by variation in the strata; and it might be better if gas managers were to have coal tested more frequently than was done. It seemed to be assumed that if coal was taken from the same seam, it would be of uniform character; but he had known this not to be the case. Coals in the neighbourhood of Newcastle appeared to vary very much indeed.

The PRESIDENT remarked that they must not always expect to have their coal quite the same. Therefore it was all the more necessary to have it tested so as to see that they were getting their money's worth.

Mr. T. BOWER understood that it was Mr. Wilson's intention, when he gave them his first paper, to divide it into three parts. It occurred to him that if this were still his intention, it would be well for the discussion to be postponed until after they had heard the third part.

Mr. WILSON said he should be very pleased to have the paper discussed as it went on. The first portion of the paper really contained nothing that could be discussed; but upon the present part he should like the opinion of gas engineers. Many analysts, when coal was sent for examination, returned the result as an ultimate analysis. They would give the amount of carbon, sulphur,

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hydrogen, and oxygen; and then, unless the sender of the coal was thoroughly acquainted with the ultimate or organic analysis, he could not make head or tail of the figures placed before him. Those who understood the translations of ultimate analysis knew that the first thing at which they must glance was the quantity of ash given; and then they looked at the amount of hydrogen and oxygen. By dividing the oxygen by 8, and subtracting the result from the total oxygen, that gave them the quantity of oxidized hydrogen, and represented the amount of what could be considered volatile hydrocarbons. This was one form of analysis which was very useful in the hands of a man who had been trained as a chemist. But for an ordinary, average person, who had not spent many years of his life in reading up chemistry and in a laboratory, something more practical, he considered, was more to the point; and he himself always, unless specially desired, quoted his analysis of coal as follows:—He gave volatile hydrocarbons, fixed carbons, ash, sulphur, and moisture. Then he gave the laboratory tests for the yield of gas per ton of coals; and thus he supplied nearly all the information a gas engineer required. In his paper, he quoted two examples. One coal—the Trimdon—gave 32·33 per cent. of volatile matter, and the other—the Hutton Henry—31·67 per cent. The difference was not 1 per cent.; and the ash of the former was 4·06, and of the latter 4·07 per cent. They were both from the same seam; and, as they might expect, the yield of gas from the one was higher than from the other. The Trimdon yielded 10,583 cubic feet of gas; and the Hutton Henry, 10,320 cubic feet. There was therefore a distinct relation between the volatile hydrocarbon and the yield of gas per ton. But what was of most interest was that the laboratory test, so far as the gas engineer was concerned, was simply a guide, but could give them no practical information. The gas engineer, in his practice, gained far more information with regard to the quality of coal than the chemist could possibly give him. The art of getting the maximum amount of gas from a given quantity of coal of a certain quality, was entirely the result of skill. One man might obtain 10,000 feet of gas per ton out of a coal; whereas another person might get much less —say, 8000 or 9000 cubic feet. It entirely depended upon the management and the experience which the engineer had had; and to turn round and judge an engineer upon the point of analysis would be not only ridiculous, but altogether out of the question. Of course, the same coal might give, and did give, in the hands of different workers, different yields of gas.

Mr. T. Bower said he did not think he was sufficiently acquainted with North of England coal to speak with any authority upon the

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matter. He was in hopes that as Mr. Wilson was very intimately connected with several of the collieries in the neighbourhood, and had also had some practical working tests, he would be able to give them a comparative test, both from a chemical and a practical point of view. He believed the author of the paper had very considerable experience with several of the Durham coals; and, if he was not mistaken, he had been the means of introducing several of those coals into gas-works in the North of England. Mr. Wilson stated that the Trimdon coal yielded 10,583 cubic feet; and the Hutton Henry coal, 10,320 feet. Well, he himself had worked the latter coal; but he had not been so fortunate as to get a yield of 10,300 feet from it. He had perhaps obtained 10,000 feet. The Trimdon coal he had not worked at all. Perhaps it might be of advantage to gas managers, if, instead of having laboratory tests placed before them, they had a contribution by a person of experience, which would enable them to reduce their working to something like a definite idea.

Mr. C. SELLERS remarked that he had found fault with the first paper; and he really did not see the merit of the present one for their Association. That was not Mr. Wilson's fault; it was the fault of the Committee who selected the paper. He thought that gas managers, as a body, knew all about the composition of coal; all about its chemical elements; all about its geological formation; and, in fact, he could not conceive of a gas manager requiring to be told anything about the "A B C" of coal. Hence, he could not enter into a discussion of the paper in any form or shape.

The PRESIDENT wished to say that, although exception had been taken to Mr. Wilson's contribution, they could learn something from everybody. He had been very much interested in hearing the paper; not only for its historical value, but for the analytical way in which it was put. The only point they were concerned about, as gas managers, was this: They ought to be able to find out from analysis more clearly than they did how the coal would work out in the retort-house. The retort-house and the laboratory test ought to correct each other; but somehow chemical analyses always told stories. Of course, they said chemistry was a perfect science; but still they found that the chemical analyses always told stories. They wished that chemical gentlemen would make a correction, and tell them exactly what could be produced from the coal. However this might be, he was sure they were all very much pleased with the paper; and he thought they ought to award Mr. Wilson their best thanks for it.

Mr. WILSON, in reply, said that, so far as practical, theoretical results were concerned, as a rule, he noticed himself that the result of a laboratory test was just about 10 per cent. above

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the retorts. He had on several occasions deducted 5 per cent. from the laboratory tests; and the last time he did this he had the satisfaction of knowing that the practical test was 2 per cent. above the laboratory test. So that really this was just the point that was rather awkward. If a chemist took 5 per cent. from the laboratory test, of course working in smaller quantities—say 100 grammes—it was natural that the yield of gas should be larger. They would have a smaller quantity, subject to a higher temperature perhaps than in the ordinary gas-retort; they had a greater control over the temperature; there would be less waste; and consequently, as was natural, they would get the maximum yield of gas from the coal. Mr. M'Gillivray, he thought, mentioned the variation in the quality of coal. He should say that this might be owing, first, to actual decomposition in the coal, or, to a great extent, due to the closeness of certain rocks which might have affected a portion of the coal. It might also be that the coal was changing, owing to the dip, or the transformation of coal into shale, or some other reason. He could only thank the members generally for the way in which they had received his paper.

The PRESIDENT said that he would just make one remark with respect to analyses. He never could understand why the analysis of the chemist should not be absolutely true in the same proportion. In fact, it ought to be favourable to the works. Supposing they made gas in small vessels, they would never get the same results. They always realized more satisfactory results from large than from small works; and so it ought to be with analysis.

Mr. WILSON: Yes, but you have picked particles to deal with in analysis.

The PRESIDENT: There it is again—"telling stories" ag
The piece analyzed is not a fair specimen. It is not what we should call a good average; and the consequence is that we find the yield high.

Mr. WILSON: As a rule the samples sent in for analysis are simply one large, beautiful piece—one block.

THE COMMISSION SYSTEM.

Mr. C. SELLERS said that since he came into Newcastle, he had been asked to submit to the meeting the necessity of entering a protest against the reflections which had recently been cast upon members of their profession in connection with what was called the commission system. This was a question to which they should give at least two or three minutes of their attention. The commission system which had recently been exploded at Salford had tended to bring on them, as members of the gas

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profession, a criticism which he considered had been exceedingly unjust to a large extent. Writers and speakers upon the subject, had referred to the commission system as a corrupt one peculiarly applicable to the gas profession. He denied this *in toto*. He had heard, and read opinions on both sides. There had been gentlemen who had written and who had spoken upon the system as quite a recent and new discovery. Now, he begged to differ from these gentlemen. The practice of giving commissions and tips was as old as the hills; and all men of the world knew that the commercial life of this country, and, he ventured to say, the commercial life of most countries at the present day, was riddled through with a similar system of tips and commissions. He was not going into the morality of any one particular case, because the morality of the questions differed very widely. With regard to the important feature of the remuneration of gas managers, which had recently been referred to, he held, from his knowledge, that they, as a body, were not paid in proportion to many other gentlemen who had responsible positions in the commercial world. They were not paid anything like the proportion they ought to be, relatively to the responsibilities of the work devolving upon them. He could not conceive of any man having more responsibility or care upon him than a gas manager. A man engaged in an office could shut his door and go home, leaving his duties behind him; but the gas manager had perhaps during the night, when he awoke, a sense of uneasiness lest something might be going wrong at the works. He perhaps had had anxiety down to the very moment of going to sleep; and the minute he awoke in the morning, he had to rush off to attend to some other anxious point in connection with his duties. All this peculiar responsibility deserved more recognition at the hands of those who employed gas managers than, he was sorry to say, it often received. They knew some managers, in charge of very large works, with heavy responsibilities upon them, who were most inadequately paid; he might say shabbily paid—paid in a way that was a gross reflection upon the authorities they served, and especially did this apply to corporations. He had already observed that the system of commissions did not exclusively apply to any one section of the commercial world. It ran through the railway system, from the highest official down to the porter who carried one's luggage. More or less, "tipping" ran through the professions. It was not a secret that lawyers could be bought and sold; neither was it a secret that doctors and parsons were also bought and sold. He said this advisedly; and all men of the world knew it. At the same time he was not casting, nor desiring to cast, any reflection upon one class more than another. There was a great deal of human

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nature all round; and he dare say gas managers had their share, though he did not allow that they had more than their share. He spoke in the way he did because those who knew him knew that he could speak with clean hands; but he was sorry to hear reflections cast wholesale upon his colleagues in a way that, in his opinion, was very unjust to a large number of very high-minded men —men as high-minded as he was himself. He was sorry he had mentioned himself, because it might seem as if he was desirous of flattery. He did not care a straw what any gentleman there might or might not think of him. He would claim the right to throw back that reflection which seemed by many writers to be more exclusively thrown at them. There was, however, one feature, which he thought belonged to this question, which they should consider. They ought to set their own house square and right; they ought to see that their Associations were framed in such a way as not to further favouritism. Let them stand before the world free from charges of favouritism in their Associations; before the public as men who were independent, and were on an equality. He was sorry to say there were reflections hanging upon the parent Association, which drew attention upon them as gas managers in that particular line, and which, he held, ought to be removed. If the gas managers throughout the country would show an independence and a determination to put their Associations upon a sound footing, where all the members would have a perfect equality, he said that those reflections to which he had alluded, would have a far better chance of being removed than they had when these reflections were hanging upon them. There was one class of men he would allude to in this particular, as a brave and sturdy class of independent souls, and that was Scotchmen. They were the flower of the gas profession in point of independence, and in point of manliness. He was sorry that amongst English managers there was a very large number who hung upon the heels of influence. They lost their manliness; they bowed to authority, which exercised itself upon them, and influenced them in a wrong direction; and they drew upon themselves the charge of cowardice and want of integrity. There were men who would whisper of charges, and would come to the meetings, but would not speak of them there. They would sit dumb; and would then go out of the meetings and whisper again. He had known men go to meetings, who did not dare to hold up their hands in support of motions which they favoured; and a reflection like this was damaging to them as gas managers, and was damaging to them in the public estimation.

The PRESIDENT said he was sure they were very much pleased with Mr. Sellers's eloquent speech. He was always eloquent; and

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he always spoke his mind. He was also sure they were very much edified by his speech; and, of course, they were pleased to hear him speak on the question of commissions. There was no doubt the system was universal. He himself had had to deal with people in many parts of the world; and he had found it to be the practice everywhere. It had almost disappeared in many quarters; but it still existed in others. He hoped, however, the system would be exterminated some day; and that they should hear no more of it.

Members in Arrear.

A resolution was subsequently adopted, on the motion of the President, to the effect that members who were three years in arrear with their subscriptions would be struck off the roll.

Office-Bearers for 1888-9.

It was then intimated that the Scrutineers' report showed the following as having been elected officers for the ensuing year:—President, Mr. Thomas Bower, of West Hartlepool; Vice-President, Mr. R. Bridge, of Doncaster; Secretary and Treasurer, Mr. William Hardie, of Newcastle-on-Tyne; Auditor, Mr. J. H. Penney, of South Shields; Committee, Mr. W. Hardie, jun., of Tynemouth, Mr. W. J. Warner, of South Shields; Mr. J. H. Cox, of Sunderland; and Mr. H. Tobey, of Malton.

Mr. Bower invited the Association to hold its next meeting in October at West Hartlepool; and the invitation was accepted.

The business then closed, and the members and their friends afterwards dined together in the County Hotel—Mr. Wyatt in the chair.

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SOUTHERN ASSOCIATION.

QUARTERLY MEETING, MAY 10.

This was the usual Excursion Meeting; and the day was spent in a visit to St. Albans, where the members of the Association and their friends were hospitably entertained by Mr. A. F. Phillips, M. Inst. C.E., the Engineer of the Gas and Water Works.

The larger portion of the party went down by coach, under the care of the President (Mr. J. L. Chapman, of Harrow) and the Honorary Secretary (Mr. J. W. Helps, of Croydon). Starting from London shortly after ten o'clock, they drove to Bentley Priory —formerly the Hertfordshire residence of Sir John Kelk, the well-known contractor, and now a rural appanage of the Grand Hotel, Charing Cross—where a luncheon was provided by Mr. John Chapman, of Stanmore. Leaving this beautiful halting-place, the expedition soon reached St. Albans, where Mr. Phillips was awaiting his guests of the day. Here, first of all, an inspection was made of the gas-works, then on their summer footing, but interesting for the proof afforded in the retort-house of the success for this class of works of Mr. W. R. Jones's breeze furnaces.* This system of retort furnace construction consists in building the furnace proper in two storeys. The lower one is an ordinary fire-grate of bars over an ash-pan, and about 2 feet above it, or perhaps higher (for the two should not be too close together), is a contraction of the sides of the furnace by means of large fire-clay blocks which only leave a narrow longitudinal slit. It is, in short, a slit-furnace built over a grate furnace. The principal centre of combustion is the upper, or slit furnace, into which the coke or breeze fuel is put. The fire on the lower grate is only a slow one, intended to keep the slit free. The combustion is by no means intense; and the labour of clinking is reduced to merely clearing the slit by means of a pricker. This, however, must be constantly and regularly attended to. Mr. Phillips has expressed himself as greatly pleased with the economy and efficiency of this type of furnace. The consumption of coke with breeze is at the rate of from 16 to

* These furnaces were described and illustrated in the *Journal of Gas Lighting* for March 2, 1886 (p. 397).

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18 lbs. per 100 lbs. of coal carbonized; and the furnaces last literally for years without renewal. He regards them as peculiarly adapted for small works, in which neither the money for building nor the skill for managing the best types of regenerator furnaces are available. Another object of interest in these works was the Feldmann sulphate plant, which was working very satisfactorily, and turning out a beautiful product.

Leaving the gas-works, the visitors were shown a 12-horse power nominal "Otto" gas-engine, employed in pumping water for the supply of the town. The motor and pumping machinery form a neat combination, and are well housed. The engine develops 21-horse power actual, and pumps 14,000 gallons of water per hour against a head of 180 feet. The suitability of gas power for such work is well demonstrated in this example. It had been intended to show the other water-works plant of the town; but time would not permit, as there was so much else to be seen. The opportunity was taken for paying a visit to the extensive orchid nurseries of Messrs. Sanders and Co.

A visit was then paid to the Abbey Church—one of the oldest of national monuments—in the restoration of which, at the cost and under the immediate supervision of Lord Grimthorpe, it was found that a great deal had been done since the place was visited by The Gas Institute in 1884. The party had the advantage of an explanation of the architectural features of the building by the Venerable Archdeacon Lawrance, the Rector of the parish.

From the Abbey the visitors repaired to the Town Hall, where they dined with Mr. Phillips, who later on expressed his pleasure at receiving them in this friendly fashion, since his multifarious duties—involving, as they do, frequent and irregular absences from England—prevent him from accepting the position of President of the Association, for which he has been twice named. The toast list was commendably short; the only speakers being the host himself; Mr. C. Gandon, the President of The Gas Institute; the President of the Association; Mr. T. Willshire, the Chairman of the St. Albans Gas Company; and Mr. John Chapman.

The visitors returned to town by train, thoroughly pleased with the day's excursion, the credit for so successfully organizing which must be apportioned between the President and the Secretary, who thus managed to add one more to the pleasant meetings recorded in the history of the Association.

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MIDLAND ASSOCIATION.

QUARTERLY MEETING, MAY 17.

This meeting was held, by the kind invitation of the Directors of the Bath Gas Company, at the Company's works in the Upper Bristol Road, Bath. On the arrival of the members, they were very courteously received by the Deputy-Chairman of the Company (Mr. Commans), another of the Directors (Alderman J. S. Bartrum), the Engineer (Mr. C. Stafford Ellery, Assoc. M. Inst. C.E.), and the Secretary (Mr. George Helps). Refreshments having been partaken of, the party visited the different departments of the works, under the guidance of Mr. Ellery and his assistant (Mr. Davis). At the close of the inspection, the members assembled in the Board-room, where the business of the meeting was transacted, under the presidency of Mr. HENRY HACK, M. Inst. C.E., of Birmingham.

The PRESIDENT opened the proceedings by alluding to the presence among them of Mr. Commans and Alderman Bartrum, who, he said, had come to offer the Association a hearty welcome. He hoped the members would show their appreciation of this kindness by according them a hearty vote of thanks.

The motion was carried with applause.

The HONORARY SECRETARY (Mr. W. R. Cooper, of Banbury) then read the minutes of the previous meeting, held at Birmingham in February (see *ante*, p. 17), as well as letters of regret and apology from several absent members and invited guests.

The PRESIDENT next proposed the election of Mr. James Elliott, of the Ludlow Gas-Works, as a member of the Association.

Mr. H. PEATY (Burslem) seconded the motion, and it was unanimously carried.

Mr. C. S. ELLERY then read the following paper:—

NOTES IN THE RETORT-HOUSE.

Antiquarians, reading back the geological history of Western Europe, tell of a Stone Age, followed by a period known as the Bronze Age, which preceded the Iron Age; and in the gas world, if one may use such an analogy, there have been periods marked by certain sudden or deliberate changes in the methods of working

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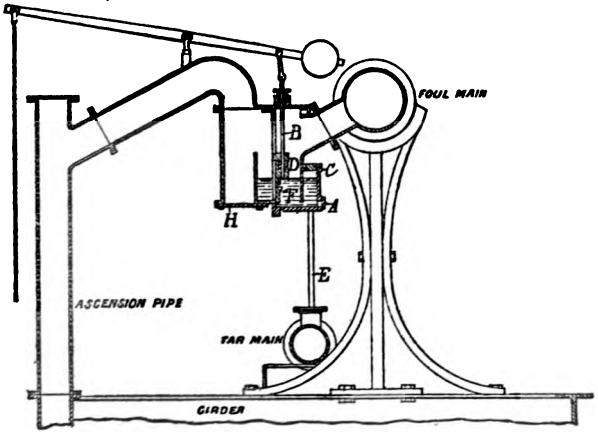
—such as, for instance, the transition from iron to clay retorts, the introduction of exhausters and regenerative furnaces, and again when the hydraulic main, having rendered real service, looked like disappearing before the methods of isolating retorts by means of anti-dip valves. Here, however, the analogy fails; for, after a brief period, the older method seems to have reasserted itself, and talking of anti-dips to-day is something very like dealing with ancient history. Yet I venture for a short time to ask your consideration and criticism of the subject. It was thought worthy of discussion some seven years ago; and I have pursued it ever since, in the firm belief that ultimately it would be found to be the most scientific, practical, and economical method of connecting the retorts with other portions of gas-making plant. It is sometimes complained that discussions are invited on ideas, freshly conceived and suddenly thrust into prominence, which a short experience would prove to be pretty, perhaps, in conception, but utterly worthless in practice; and which should never, therefore, see the light. This charge, I trust, is not deserved in the present case. We have for some six years worked the anti-dips; and these "notes" are based on observed results.



A. Port for clearing valve. B. Spindle. C. Tar-overflow.
D. Valve-slide. E. Tar-pipe (1¼ inch wrought iron). F. Spring.
H. If desired, gas can enter here, instead of as shown.

FIG. 4.—ANTI-DIP ARRANGEMENT AT THE BATH GAS-WORKS.

In 1881, the retort-house to be referred to was fitted up with 112 anti-dip valves, of the pattern shown on the diagram. It is not urged that this particular valve has any special merits; attention is rather invited to what I venture to call the principle involved in the system of working with anti-dips. If this or any other valve

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fails when put to practical test, the principle must not in consequence be condemned. Because high heats sometimes choke ascension-pipes, this is not considered sufficient reason to condemn their use. And so it is with other portions of plant. Imperfect construction or mistakes in working out details should not be permitted to exclude any right and sound principle. My contention to-day is that the principle of the anti-dip is more scientific and economical in actual working than our much-respected old friend the hydraulic main.

There never was a time, perhaps, when greater attention was paid to every method by means of which any increase in the quantity of gas may be profitably extracted from each ton of coal. This desire to bring forward to the station meter every available foot of profitable gas, has directed attention, amongst other things, to methods of rapid charging. This is clearly evidenced by the growing feeling in favour of mechanical stoking, since by such means only does it appear possible to place proper charges within the retorts in such a manner as to avoid waste of gas. It is a matter of regret that some less elaborate machinery, more within the reach of medium-sized gas-works, has not been introduced. Here is a field for enterprise and ingenuity! Not that I would say one word that may appear to disparage those machines already in the market; but their very costliness and complexity is a bar to their introduction into the majority of towns. Attention will doubtless continue to be directed to this need, until existing systems are modified or supplemented by others. Not only to rapid charging, however, but also to the construction of furnaces and retort settings, has this desire fixed attention. I observe that it is not yet fully admitted that high heats produce most profitable returns from every description of coal carbonized. It would be most valuable information if some reliable figures were arrived at and published, showing the exact effect of various temperatures in carbonization. So far as my experiments have gone—and we have made not a few—all doubt has been dispelled, if I ever had any, as to the advantage of working with high heats. The coals, then, have been carefully and expeditiously shut in the retorts, heated to a temperature best calculated to disengage the gases and liquid products as rapidly and completely as may be, attention has been directed to the engine-room, and exhausters are now running which produce diagrams which would have looked impossible to the pioneers of gas making.

Now, here comes the point of this paper. If so much care has been taken in the retort-house and engine-room to set up only those conditions most favourable to the production of gas, why spoil all by intercepting or interrupting its flow from the heated

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retort by any sort of seal or dip? I believe it is generally admitted that the pressure caused by the hydraulic seal does, to some extent, diminish the yield of gas, even when the seal is reduced to a minimum; but the revelations which are made by continued and systematic observation of the pressure in ascension-pipes point conclusively to the fact that it is next to impossible to regulate it to one unvarying line. The withdrawal of all tar from the bottom of the hydraulic main is a distinct advance in the desired direction; but much trouble and anxiety follow in its train. A sudden and mysterious disappearance of the water (probably licked up by the heat) offers an "open port" to the gas, without warning; or a slight stoppage in the regulator increases the seal to an extent that must, and certainly does influence the returns. I am aware that a supply of water to the hydraulic main mitigates, if it does not cure, the evil; but the evil is to hand ready to assert itself immediately the supply of water may for any reason be interrupted. When the hydraulic main rests on the retort arches, it is no uncommon thing to find a difference of level of 2 inches or more; increasing the seal, and correspondingly augmenting the pressure in many of the retorts. The evil has been remedied in many cases by throwing girders over the beds, and supporting all the ironwork on columns. This is a great improvement, but still greater if pursued a step farther, and each bed connected to a distinct length of hydraulic main, fitted with a valve which is closed when the particular oven is thrown out of action. Thus one sees how, in various ways, much has been done to minimize the evils attending the use of the hydraulic main, without referring to the expenditure of brain power and money in trying all conceivable forms and "dodges" for clearing and keeping it clear. But the result is still most unsatisfactory; whereas by carrying the isolation, not to a single bed only, but to each retort, all pressure and oscillation are overcome, and a free passage opened between the retort and the exhauster.

But the practical question is: Can any means which shall be workable and dependable be employed to secure this result? An experience of six years enables me to answer this question, with confidence, in the affirmative. We are working one house entirely on this principle; and my only regret is that all the retorts in the works are not similarly fitted up. The diagram shows how the arrangement is carried out.

To the main as it leaves the retort-house is fitted a governor, by which the vacuum in the pipes is regulated. I lay on the table before you a number of diagrams, which were not taken for the purposes of this paper, but which show the pressure in the ascension-pipes fitted with dips. Only those who have patiently watched

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these pressures can fully realize the strange variations which occur from time to time in the same pipe. But turning from these to the diagrams taken where the anti-dips are in action, a great difference is to be noted. Here there is little or no pressure or oscillation. The vacuum is regulated according to the illuminating power of the gas produced. To ascertain its value readily and at once, I have devised an arrangement to which I may perhaps ask your attention. It often happens that the jet photometer fitted to the exhauster outlet indicates loss of illuminating power in the gas being made; and where three or four houses are connected to one exhauster, it is difficult to trace the origin of the mischief—that is, to discover which house is at fault. To meet this difficulty, I have fitted up a special motive-power jet photometer, with purifier and gauges, in each retort-house; and by observing these the foreman knows the quality of gas turned out from each house. This light stands near to the governor, and guides the foreman in regulating the amount of vacuum necessary with the particular coals he may happen to be using. Were it not for variations in the quality of coal, a constant line might be kept. A leaky retort or lid is quickly detected by means of this light.

In many places where the anti-dip has been suggested, the hydraulic main is still retained. I feel some hesitancy in expressing my views on this part of the subject, because of the respectable array of supporters of the proposal; but if the whole truth must be told, I consider it a mistake to continue the hydraulic main, with all its inconvenience and cost, when, in my opinion, it is absolutely unnecessary—and worse than unnecessary, perhaps—because the tendency to fill with thick tar is greater when the gas is bye-passed through an anti-dip and the commotion caused by the gas forcing the dip-pipe ceases. If anti-dips are to give the satisfaction that is possible to them, the hydraulic main must make way for a gas-main, and the seal be altogether discarded. But in fixing anti-dip valves, one point of paramount importance must be observed; and the neglect of this has, in my opinion, caused much trouble and disappointment. I refer to the position of the valve. When the system was first tried in these works, the valves were placed on the top of the ascension-pipes; and much trouble was caused by accumulation of thick tar. This was overcome by putting back the valves, and connecting them direct with the gas-main. In this position they work with success, and require but little attention. A man goes round once a day to oil the working parts; but for months we have had them continuously in action without opening one on account of derangement. If the tar should occasionally thicken, the man inserts a hot rod in the port prepared for the purpose (marked A on the diagram) whilst the retort is working;

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and in a few moments the flange is replaced. The retorts make sufficient tar and liquor to keep the valves sealed; and by dealing with each retort separately, the tar is quickly changed in the valve and so improved in quality. Anti-dips are not a cure for choked ascension-pipes. This evil is a "Will-o'-the-Wisp," which eludes the grasp and perplexes the searcher the farther he follows its erratic movements. In the house referred to, only the centre retorts give trouble in this way; but the trouble exists. It has been greatly reduced by other methods; but I cannot say that anti-dips are a perfect cure.

I have been rather curious to learn, if possible, something of the conditions which favour the deposit of carbon within the retorts. This is obviously a case of "matter in the wrong place;" and it is noteworthy that the deposit is considerably less in retorts where the seal has given place to the valve. I have made a careful examination, under the microscope, of samples taken from retorts fitted with and without dips. In each case the mass is built up of a number of layers or skins. This, indeed, is clear to the naked eye; but with a moderately high-power glass, these laminæ are seen to be, not flat scales or plates with smooth surfaces, but innumerable bladders or globules. In the carbon taken from dip-pipe retorts, these vary in size, are all more or less crumpled or wrinkled, some curiously punctured, others slit or burst, and in one portion of the mass I observed a channel cut much like that grooved by worms in wood. In the carbon from anti-dip retorts, many of these appearances were wanting. The globules were very small, more uniform in size, and less crumpled; the mass was denser, and did not show any holes or slits. The inference I draw from all this is that the dense vapours (which may perhaps be more correctly termed "liquid") given off by the coal, are at intervals too heavy to force the seal, and become deposited on the sides of the retorts as a skin or coat, while the lighter contained gases are driven off by the heat, and, in making their escape, cause the cracks, holes, and channels in the globules before referred to. This process being continued, the carbon laminæ are consolidated into a dense mass of more or less wrinkled and crushed globules.

Passing to the consideration of the convenience of anti-dip valves, it would be possible to say much; but for the present it must suffice to remark that when a retort or retorts may be put out of work for repair, scurfing, rest, or renewal, all that is necessary is to simply close the valve. It has been objected that any appliance requiring attention from the stokers is to be deprecated; but experience shows that in this matter there is no practical inconvenience. Certainly this is more than counterbalanced by the lessened labour in regulating the hydraulic seal. I should be glad

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to place on record some figures from actual every-day working, to show the saving of gas effected by using anti-dips; but with our railway and other arrangements, this is very difficult and uncertain, even when taken. From some experiments made with our coal-testing apparatus, I have confidence in setting it down at about 200 cubic feet per ton of coal carbonized at least. As to the relative first cost of fitting up, much depends upon the arrangement with which comparison may be made. Speaking generally, I believe such outlay would not very much exceed that of modern houses in which the hydraulic main is in sections, connected to a common gas-main by means of regulating or weir valves. But apart from cost, or even saving of gas, I am convinced that, for convenience and regularity of working, anti-dips are preferable, and, in the end, will supersede hydraulic mains and dip-pipes.

Discussion.

The PRESIDENT: We have listened to some very interesting information, which Mr. Ellery, in his modesty, calls "Notes" in, but which we shall all agree amount to an able paper on the "Retort-House." Without good management and arrangement in the retort-house, we are not likely to obtain such results as we desire. It is an acknowledged maxim that our profit is made (or lost) therein; and any defects there will be clearly indicated by our half-yearly and yearly returns.

Mr. J. TINDALL (Walsall): I should like to say here what I said in the retort-house—that it seems to me that a properly regulated bench of retorts, with each setting connected to an exhaust-main by a slide-valve, so that perfect control may be had over the dip or seal, is a more simple and satisfactory arrangement than the anti-dip. Mr. Ellery claims a saving of 200 cubic feet per ton of coal—say, about 2 per cent. This, to my mind, is important; but I am afraid that the illuminating power of the gas is to some extent reduced—at least there is a danger of it being so—to obtain this additional bulk of gas. The quantity we made per ton of coal last year was 9850 cubic feet without the use of cannel; and I am sure I should be afraid to take 200 cubic feet more out of a ton of coal with any arrangement of anti-dip. In reference to simplicity of arrangement, there is a decided advantage in favour of the hydraulic main and a proper seal. In the anti-dip system, constant attention has to be paid to the opening and shutting of the valves and other matters, which are all obviated by the method adopted in our own retort-houses.

Mr. J. WEST (Manchester): Greatly as I used to respect our old friend the hydraulic main, I am now a much firmer believer in Mr. Ellery's ideas; and I have carried them out on a large scale.

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Some 15 or 16 years ago, I put down a number of anti-dips. At the new works of the Manchester Corporation in the Bradford Road, there are 500 anti-dips, working under the most severe conditions —with high heats and everything that leads to stopped pipes and difficulties. They get a make of from 9000 to 10,000 cubic feet per mouthpiece; and they do not have stopped pipes. If anti-dips are placed in the proper position, this does not happen; but there have been many failures from their being located too near the mouthpiece. Where you have an anti-dip, you should be able to bear your hand on the valve during the charge. If you can do this, it is satisfactory; but otherwise you get the pipe clogged and stopped through excessive heat. One important point is as to the amount of vacuum or pressure in the retorts. I should like to know if Mr. Ellery works with a vacuum or with a pressure. My own idea is that there should be the slightest possible pressure you can have in the retorts. I have seen diagrams of 24 hours' working in connection with the exhausters, where you get a straight line and no pulsation at all; in which case there is seldom a stopped pipe. As to the extra make of gas, I should be inclined to go farther than Mr. Ellery. It would be well if he could obtain more data; but my own conviction, founded on much experience, is that we get more than Mr. Ellery states from the adoption of the anti-dip. As to the expense of the anti-dip, it is more, I think, than the ordinary method of the hydraulic main; but, taking all things into account, this is a small matter when by these means you go a long way towards the prevention of stopped pipes. Mr. Ellery spoke of a gain of 200 cubic feet. I think it would be better if he stated the result in units of light.

Mr. TINDALL: When Mr. West speaks of over 200 cubic feet, does he refer to the most modern arrangement of the retort-house, and under proper exhaust?

Mr. WEST: Yes; I am referring to a water-seal.

Mr. R. O. PATERSON (Cheltenham): I agree with a great deal that Mr. Ellery has kindly laid before us; but I do not altogether agree with him in some of the statements he has made. Before discussing the kernel of his "Notes," I should like to offer one remark, which I am surprised Mr. West did not make, with regard to mechanical stoking. I do not agree with Mr. Ellery when he says that we are still without a simple, cheap, and efficient mechanical stoker. I have been working for some time with Mr. West's hand-stoking machine; and I can assure the members of the Association that it is a very admirable piece of apparatus, remarkably simple, and reasonably cheap. We do not expect Mr. West to give us the fruit of his brains for nothing; but I have no reason to complain of the cost of the machine, and its efficiency is well assured in my

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mind. Leaving that, I agree entirely with Mr. Ellery that the anti-dip is a scientific, and at the same time a practicable appliance. On the other hand, I can easily understand that Mr. Tindall and others may think differently. When I first took charge of the works at Cheltenham, I went there imbued with all the accepted ideas about the beautiful simplicity of the hydraulic main. But when I entered the retort-houses at Cheltenham, I did not see any hydraulic main—each ascension-pipe having its own valve. I was not all at once a convert to the anti-dip, I assure you; but seeing that Mr. Esson, my predecessor, had worked with it all his active life in Cheltenham, and that he had been preceded by Mr. Spinney, one of the pioneers of gas engineering, who also worked with it, I thought there must be more in the system than I had supposed or given it credit for. I made up my mind, therefore, to do the best I could with it; and now I should never dream of going back to the hydraulic main. It may be asked on what grounds I base my preference for the anti-dip. There is my difficulty. I have had no experience at Cheltenham with anything but the anti-dip; and I cannot give a comparison of work with the hydraulic main. But, on scientific principles, I think one is justified in saying it is injurious to interpose a hydraulic seal between the retort and the exhauster. On this ground, I am prepared to stand by the anti-dip. I am not surprised, on the other hand, that those who have been working with hydraulic mains all their lives should adhere to them. It will take a long time to convince gas engineers that they can work without the seal; and till that time comes, the hydraulic main will hold its own to the exclusion of anti-dip arrangements. I know nothing of Mr. Ellery's plan. I have on the bridge-pipe simply a throttle-valve, which is operated by a lever, very much in the same manner as shown in Mr. Ellery's diagram. I was hoping Mr. Ellery might be able to give us reliable figures, showing the difference of working with the hydraulic main and the anti-dip. I do not look upon the estimate we have had as a fair one; and, besides, it is only an estimate. The difference is considerably more than Mr. Ellery is prepared to put it at. The position Mr. Ellery took up in reference to the introduction of all the most modern appliances and scientific apparatus for the better and cheaper production of gas from coal by the gas managers of the present day, and from that vantage-ground dealing a left-handed stroke at the hydraulic main, is not altogether justified by the facts laid before us, because he has not shown any very great advantage from the working of the anti-dip. I think that Mr. Tindall's is a stronger position than Mr. Ellery's on this point. Mr. Tindall says that if there is only a gain of 2 per cent. in the yield of gas, it is not worth the trouble and expense of the

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change; and he is probably right. But, in my opinion, Mr. Ellery has considerably under-stated the case. Perhaps he was wise to do so. The trouble of stopped ascension-pipes, to which Mr. Ellery alluded, and which he stated is not cured by the anti-dip, is a matter which I can corroborate. In some sections of my works I have been considerably troubled with stopped pipes, although there is no hydraulic main; but, on the other hand, I have sections where there are no stopped pipes, although the production of gas per mouthpiece is large. The anti-dip is not, therefore, a cure for stopped pipes, but reduces the density of the material found in the pipes; and there is a considerable diminution in the quantity of carbon deposited in the interior of the retort.

Mr. C. Taylor (Derby): Unfortunately, I have not had any experience with anti-dips—my experience having extended to the hydraulic main exclusively; but last year I made an average of something like 9800 cubic feet of 17½-candle gas, or even more than that, from the net 20 cwt. of ordinary Derbyshire coals with a percentage of Yorkshire. I have a good many stopped pipes; but I do not imagine they are due to the sealing of the dips in the tar. It does not appear to me that there is much advantage in employing anti-dips. Such arrangements as those shown on the diagram involve the condition that the pressure in the retorts shall be reduced to level gauge; and any alterations of pressure and vacuum arising from the pulsations of the exhauster will at one time expel gas and at another draw in air, especially at the valves standing out of action, and so lead to a reduction of illuminating power. I agree with Mr. West that, for proper comparison, it would be better to have the results with and without the anti-dips expressed in units of light. I should like to ask the size of the tar overflow-pipe shown on the diagram, and whether it stops up and causes inconvenience; also what has been the percentage of stopped pipes when working with the hydraulic main, or, approximately, what has been the cost of cleaning them out? Mr. Ellery tells us that one of the men has to go round daily to look after the anti-dip arrangements. Does the cost of doing this amount to much—say, £50 per annum, or anything like it?

Mr. J. S. Cranmer (Stratford-on-Avon): I understood Mr. Ellery to remark, in reading his paper, that he should like to have someone's experience of the hydraulic main in sections. During the past two years, I have had some little experience in that way, having three beds of retorts, to each of which there is a separate hydraulic main. The first year I placed in the hydraulic main a seal as near one inch as possible, and had an arrangement to take off the whole of the tar. In that year the pipes were continually stopping, and were the cause of a good deal of trouble. Last year

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I altered the depth of the seal; and in the course of the past nine months, I have rarely had a stopped pipe. That is the difference between having an ascension-pipe with scarcely any seal to it; you may almost call it an anti-dip, when I say I worked with a three-quarters to one inch dip, and an exhaust vacuum of an inch, and that there was scarcely any dip on the ascension-pipe. Last year I worked with an increased dip and a level gauge; and my yield of gas was equal to the previous year, stopped pipes were almost *nil*, and the other results were nearly as good. I am now working with another section of retorts, the ascension-pipes of which are connected with a hydraulic main in one length. A dip of 2 inches is given; and I do not have a stopped pipe—the other results being equally good. The question of stopped pipes is, as Mr. Ellery says, a "Will-o'-the-Wisp."

Mr. J. T. Lewis (Wellingborough): I cannot agree with Mr. Ellery when he says that the cause of stoppage in ascension-pipes is like a "Will-o'-the-Wisp;" for my experience proves that it is entirely a question of temperature. For several seasons I worked my retorts at a high temperature—making from 10,400 to 10,500 cubic feet of 16·25-candle gas from a ton of South Yorkshire coal; and not a day passed without having stopped pipes to attend to. During the past two seasons, I have reduced the temperature, so as to make from 10,150 to 10,250 cubic feet of 17·5-candle gas from the same kind of coal; and it is very rare we get a stopped pipe. But when this does happen, I invariably find it is caused by an increased temperature in the setting. When this is reduced to its normal state, the stoppages cease.

The President: I am glad there has been this discussion on a subject which interests all of us so much. If I thought myself that the adoption of anti-dips would materially reduce choked ascension-pipes, I should most certainly give the matter very grave consideration; for they have for a long time past been to us one of the greatest bugbears I have ever had to contend with. I think I have tried every conceivable thing as a remedy; and so far without success. What has been believed to be a cure for them one week has turned out the contrary the following week. One cause, to my mind, is the great oscillation which occurs in the retorts. I have not had an opportunity of comparing for myself the working of the two systems of dips and anti-dips; but the great and varying oscillation that takes place where the dip is employed deserves attention in connection with the question. I find that it very often reaches 20-10ths and upwards; that is with a dip of 2½ inches, and an exhaust of 2 inches—thus leaving about ¼-inch seal. One would think, with such a small seal as that, there would be but little oscillation in the retort. With regard to

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Mr. Lewis's statement as to the heats, it does naturally strike one that one of the chief causes of choked pipes is high heats; but at times I have found that with high heats (not assumed, but as recorded by the pyrometer), we have not had any stopped pipes, while with lower temperatures we have been much troubled with them. No doubt this serious nuisance is occasioned by a multitude of things; and the suggestion thrown out by Mr. Ellery to-day is a valuable one. This matter of stopped pipes has been before the profession a long time; and we hear of works where they are a constant trouble, and of others where they are not known. We hear of "cures," and anxiously try them, with little or no avail. To have proper and reliable data, as regards the subject Mr. Ellery has brought before us, I think it would be very desirable for one or more of us to set aside a bench of retorts at a convenient season, and compare the results obtained over a sufficiently long period with dips and anti-dips respectively—using in each case precisely the same coal; and in order to make the test valuable, all the conditions, temperatures, charges, &c., should be as nearly alike as possible. In this way we might get a fair comparison of the two systems, as regards stopped pipes and in other respects. I feel it is a matter of reproach that we have not yet found out a real remedy, and put an end to the worry and loss occasioned by stopped pipes. Another desirable thing in connection with the test suggested would be to ascertain the quantity and value of the residual products, as it may be at times to our interest to get a large yield of gas, with less tar and less ammoniacal liquor, while the state of things may be different on another occasion, and render the opposite course advisable. All the residual products should, therefore, be always carefully recorded. I do not quite understand whether or not Mr. Ellery is working with a level gauge in the hydraulic main where the anti-dips are in use. I should be glad if he will make this point clear.

Mr. Ellery: Someone noticed the short chimneys in our retort-houses, and asked why they were used. I have always been under the impression that for each bench of retorts—that is, for each fire—one small chimney is most advantageous. Although, where tall chimneys and main flues are used, the dampers may theoretically be all regulated alike, yet there is a tendency for the draught on the benches nearest the stack to be strongest. A separate chimney for every furnace tells the tale if the retorts are charged without patching when required; and the man who is neglectful can thus be detected. Mr. Tindall went distinctly against the suggestions I threw out; but I should like to have heard some stronger arguments on his side. The make of gas depends upon the quality of the coal. I give you, as a matter of fact, the difference in the yield from the

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same coal by both systems. I stated a gain of 200 cubic feet; but some tests show 500 feet, and others less than 200. But, without overstating the case, I find the difference in the yield by the same coal is 200 cubic feet in favour of the anti-dip. I should like to ask Mr. Tindall whether he has taken pains to ascertain what is going on in his ascension-pipes. We find at one time there is an absolute vacuum, and soon afterwards 2 or more inches of pressure on the same pipe. With such a difference, you cannot arrange to work satisfactorily. Where you cannot have an open way direct to the exhauster, these fluctuations—I do not think "oscillations" is a word strong enough—occur. Anyone who may not have watched what is going on in the ascension-pipes, will find it instructive to try and find out. It has been remarked that where there is carelessness with the exhauster, bad gas is passed to the gasholder. That is equally possible with dip-pipes; only greater care and attention are needed. Instead of one detective, I have a man in the retort-house watching the light, and the man in the engine-house attending to his part of the work. As to Mr. West's remarks, I aim to work with a level gauge in the retorts. At the outlet of the house we keep about half-a-tenth vacuum; and this produces a level gauge in the ascension-pipes. As to stopped pipes, I do not say that anti-dips are no help; I stated that they were not a perfect cure. As to giving the results in units of light, I tried to make it clear, by taking the gas at the same illuminating power (15 candles), that there is a saving of 200 cubic feet per ton. Mr. Paterson found fault with me for asking for a more simple mechanical stoker. When you put on the cost of the wear and tear of machines, interest on the outlay, and working expenses, it adds too much to the charges for making gas, when the total carbonizing charges are only 2¼d. per 1000 cubic feet. Mr. Paterson will excuse me holding to my point—that we want a simpler, and certainly a cheaper machine for medium-sized works. These valves require attention. It takes a man, on the average, about an hour a day to see to them. There is another point I should like to answer. One gentleman reduces his yield 250 cubic feet per ton to prevent choked ascension-pipes.

Mr. Lewis: The illuminating power increases.

Mr. Ellery: I understood the heats were dropped in order to cure the blocked pipes.

Mr. Lewis: I said I lowered the heats, and the stoppages in the pipes ceased. I obtained 16-candle gas with the higher yield, and now 17¼-candle.

Mr. Ellery: I think we do not yet understand the full effect of varying the heats in carbonizing. I believe that reducing the heat causes a loss; but we need some exhaustive experiments on this subject.

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Mr. TINDALL: Mr. Ellery asked me if I had taken diagrams of the ascension-pipes, and I may say I have not. Since I have isolated all my settings, my exhausting is so perfect that I do not require to do so.

Mr. ELLERY: Apart from the saving of gas, the convenience and other advantages of working with the anti-dip are so great that I have no hesitation in recommending the adoption of this principle in every retort-house.

The PRESIDENT proposed a vote of thanks to Mr. Ellery.

Mr. P. SIMPSON (Rugby) seconded the motion; and it was carried unanimously.

Mr. J. T. LEWIS (Wellingborough) contributed the following paper, which, owing to want of time, was taken as read:—

THE COMPETITION OF PETROLEUM OIL AND GAS FOR LIGHTING PURPOSES.

I think you will all agree with me that petroleum is the most powerful competitor that gas lighting has to contend against at the present time—powerful because of its comparative cheapness and the easy method of its supply bringing it within the reach of all, rich and poor alike. There are some people who would have us believe that the last days of gas lighting are drawing near—that it is to be superseded by the electric light; and if any amount of "tall talk" could effect this, doubtless the end would be not far distant. There can be no question that the electric light is making some progress, and attracting a small share of business, and, as a rival, we ought not to despise it. Yet I have no hesitation in saying that, as a serious competitor, it is not "in the running" at the present time; and nowithstanding Lord Thurlow's modest prophecy, made at the annual meeting of the Brush Company on the 2nd of March last, "that by the year 1892 there will not be a gas-lighted town in the kingdom," we need not very seriously trouble our minds about this particular rival. But although this is true of the electric light, we cannot say the same respecting the competition caused by the large and cheap supply of petroleum oil. This is undoubtedly a competitor that can be both seen and felt; and it was in consequence of this competition in our own town, and the somewhat contradictory statements that have been made during the past year at various meetings of Gas Managers' Associations as to the extent of this competition, that I was led to make the series of petroleum lamp tests which I shall shortly bring before your notice.

Perhaps some of you will think such work as this should be undertaken by the lamp manufacturers or the oil sellers, and that it is

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not wise on our part to publish the results of these tests, especially when they prove that in the majority of towns the average cost of lighting by petroleum oils is lower, light for light, than that of gas. Although there may be something in this objection, I am sure we all very much prefer to learn the truth on these matters, rather than shut our eyes to the facts; for it must be to our advantage to know what it costs to produce light by any other means than gas, since with this knowledge we are able to check the statements of interested people; and, further, we know exactly what we have to contend against, which is always important when dealing with our customers.

The following tests were made on a 60-inch Letheby photometer, supplied to us about 15 months ago by Messrs. William Sugg and Co., Limited. The standard used was Methven's screen, which I need hardly say is much more reliable than candles—at least such has been my experience with its use during the past four years. The lamps employed were those on sale at different shops in the town, with the exception of two which were obtained expressly for me; and they include the best lamps manufactured. The oil was best refined American petroleum, having a specific gravity of ·800 as compared with water 1·000, and therefore weighed 8 lbs., or 56,000 grains, per gallon. Every care was taken to ensure correct results. The wicks were carefully trimmed before each test, so that the flame was equal in all parts. The time of each test was, in nearly all cases, 30 minutes; the lamps being carefully weighed whilst burning, at the commencement and close. The plumb-lines of the photometer cut the centre of Argand flames, passed through the edge of the flames of single-wick burners, and through the central point edgewise between the two wicks of duplex burners. I have taken the cost of gas at 3s. per 1000 cubic feet; and, for the sake of comparison, I have estimated that each foot of gas would yield a light of 3·2 candles. The cost of best American petroleum with us is 10d. per gallon retail; and Russian petroleum is being sold in small quantities at the rate of 8d. and 9d. per gallon —the cost wholesale for the two kinds being respectively 6¾d. and 6½d. per gallon. It is not my intention to read the whole of the tests, but only the average of each lamp.

In tabulating the results, I have followed the method adopted by the late Mr. F. W. Hartley, in his communication to the *Journal of Gas Lighting* for May 3, 1881; these being, as far as I am aware, the only set of independent results published. [See next and succeeding pages.]

If you refer to Mr. Hartley's communication, you will find that he used different values per cubic foot of gas. For comparison with single-wick and duplex burners, he allows a value of only

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Petroleum Lamp Tests.

ARGANDS.

Reference Number. Lamp.	Test.	Size of Wick. External Diameter.	Illuminating Power in Sperm Candles.	Grains of Oil. Burned in One Hour.	For One Candle.	Value of One Gallon in Sperm Candles for One Hour.	Cubic Feet of Gas to yield same Light.	Cost of Gas at 8s. per 1000 Cubic Feet.
		In.						Pence.
1 D	1	1¼	30·37	1436	47·27	1184·68	370·21	13·32
	2	1¼	29·88	1353	45·28	1236·74	386·48	13·91
	3	1¼	27·55	1300	47·18	1186·94	370·91	13·35
Average			29·86	1363	46·57	1202·78	375·86	13·52
2 D	4	⅞	8·75	480	54·88	1021·33	319·16	11·48
	5	⅞	9·00	402	44·66	1253·19	391·84	14·10
	6	⅞	8·24	410	49·75	1125·62	351·75	12·66
Average			8·66	430·66	49·74	1133·62	354·25	12·74
3 PV	7	1⅞	45·25	2100	46·40	1206·89	377·15	13·57
	8	1⅞	45·80	2000	44·15	1268·30	396·34	14·26
	9	1⅞	44·25	1940	43·84	1277·37	399·17	14·37
Average			44·93	2013·3	44·79	1250·85	390·88	14·07
4 LB	10	1⅜	37·15	1500	40·37	1337·16	433·48	15·60
	11	1⅜	39·75	1520	36·84	1464·43	457·63	16·47
	12	1⅜	40·20	1560	38·80	1443·29	451·02	16·23
Average			39·03	1526	38·67	1481·62	447·37	16·10
5 E	13	1⅜	35·60	1700	47·75	1172·78	366·49	13·19
	14	1⅜	35·92	1574	43·83	1277·65	399·26	14·37
	15	1⅜	35·00	1658	47·37	1182·21	369·44	13·29
Average			35·50	1644	46·31	1210·88	378·39	13·61

DUPLEX.

			Sideflame					
6 DH	16	1	25·80	990	38·37	1459·47	456·08	16·41
	17	1	27·85	1200	43·08	1299·90	406·21	14·62
	18	1	27·12	1180	43·51	1287·06	402·20	14·47
Average			26·92	1123	41·65	1348·61	421·46	15·16

Edge of flame 37 per cent. less light than side of flame.

SINGLE FLAT FLAME.

7 C	19	⅞	8·11	380	40·69	1376·25	430·07	15·48
	20	⅞	9·90	460	46·46	1205·34	376·66	13·55
	21	⅞	9·43	440	46·7	1199·14	374·73	13·49
Average			9·14	410	44·61	1260·24	393·82	14·17

Edge of flame 21·44 per cent. less light than side of flame.

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AVERAGE OF ALL TESTS.

1 D	..	1½	29·86	1363	46·57	1202·78	375·86	18·52
2 D	..	⅞	8·66	490·6	49·74	1133·62	354·25	12·74
3 PV	..	1⅞	44·98	2013·3	44·79	1250·85	390·88	14·07
4 LB	..	1⅝	39·03	1526	38·67	1431·62	447·37	16·10
5 E	..	1⅝	35·50	1644	46·31	1210·88	378·39	13·61
6 DH	..	1	26·92	1123	41·65	1348·61	421·46	15·16
7 C	..	⅞	9·14	410	44·61	1260·24	393·82	14·17
Average			27·72	1215	44·62	1260·37	394·57	14·19

AVERAGE OF MR. HARTLEY'S TESTS TO SAME VALUE AS ABOVE.

Single wick	9·69	581·84	61·41	911·88	284·93	10·25
Duplex	20·24	1146	56·76	986·61	308·30	11·09
Argand	11·18	638	57·57	970·99	303·40	10·92
Average	13·70	788·61	58·58	956·49	298·87	10·75

2·4 candles, and for Argands a value of 3 candles per cubic foot. The selling price of gas he took at 3s. 4d. per 1000 feet. As you have seen, the results obtained with the lamps in use at the present time are superior to those obtained with the lamps used by Mr. Hartley; showing that great improvements have been made since 1881 in the lamps, or perhaps it may be the case that both oil and lamps have improved. But however great the improvements made in oil-lamps may have been, the improvements made with gas-burners have been equally great; and therefore I thought it right to take the duty as 3·2 candles instead of 2·4 or 3 candles per cubic foot of gas.

You will notice that the results obtained with the No. 4 lamp were especially good. This lamp is used extensively on the Continent, and is deservedly thought very highly of. This is the class of lamp spoken of by *Engineering*, in an article on "The Relative Cost of Gas, Oil, and Electricity in Russia," as that which should be used in comparison with gas. An extract from this article will be found under the heading of "Notes" in the *Journal of Gas Lighting* for April 3 last (p. 594). If the comparison is made between the best classes of oil-lamps and regenerative gas-burners, we shall be quite satisfied; but it is most unfair to compare the best class of oil-lamp with only a poor class of gas-burner. As I have before remarked, every care was taken to ensure correct results; and I do not think it would be possible for users of these lamps to obtain such good results in every-day use.

It must not be forgotten that the cost of oil is not the only item to be taken into account. Fortunately for us, there are other serious considerations. The annoyance of smoky lamps and broken chimneys, the trouble of filling the lamp with oil at frequent intervals, and the cost of the wick are some of these. Several of the lamps tested were quite free from the danger of explosion or fire; but I need hardly say that the majority of the lamps in general use are very far from safe, as the lamentable records of the daily papers

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prove only too well. It is true that accidents happen through leakages of gas; but I think we shall find that in nine cases out of ten the accident might have been prevented, if, on the discovery of the leakage, the common-sense precaution had been taken of avoiding the use of a light until ventilation by doors or windows had removed the source of danger. But with oil-lamps there is no warning. The lamp may be dropped, or in some way thrown over; and in a moment the clothing is on fire, and the result is loss of property, or, worse still, loss of life. Those lamps which give such high illuminating power are very suitable for the lighting of shops and shop windows, where a bright light is required; but when used for house lighting, they require a globe or shade of some kind, to tone down the intense glare of the light. The loss of light when an opal globe is used is 39·8 per cent.; and with a frosted and relieved globe, 30 per cent.

In towns where the price charged for gas is 2s. per 1000 cubic feet, the cost of oil is about equal to that of gas; the value of the gas required to yield the same amount of light as one gallon of oil being 9·45d. The following circumstance, however, will prove that price is not the only consideration:—The Midland Railway Company have one of their stations lighted with petroleum lamps; but, notwithstanding that the illumination is satisfactory, they are willing to substitute gas, provided it can be supplied at 3s. 2d. per 1000 feet, certainly not because gas will cost them less, but because other things are more important than the actual cost of light.

When we come to compare the results obtained with the oil-lamps, and the best class of regenerative gas-burners, giving a duty of from 6 to 10 candles per cubic foot of gas, there can be no question as to which is the more economical in use for light only, leaving out all other considerations. In the early days of regenerative lamps, they were most unsightly things; and it is with much pleasure I acknowledge the transformation that has taken place in their appearance. Now they can be obtained in a great variety of beautiful and artistic designs; and the only obstacle to their more general use is their somewhat excessive cost. Incandescent burners, although very beautiful in appearance, and yielding good results for the quantity of gas used, are not, in my opinion, adapted for the general consumers' use, owing to the fragile nature of the material to be raised to incandescence. They are expensive in first cost; and I fear that the frequent renewal of the hood would prevent much, if any, economy by their use.

Much ignorance prevails with many of our customers as to the mode of burning gas. They appear to think that so long as they have something at the end of the pipe with either a slot or holes in it, it is all that is required; and if they fail to obtain a good

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light, they accuse the suppliers of sending out gas of bad quality. Unfortunately, such is the prejudice, that they will readily place reliance upon the statement of the hawker of burners when the gas manager's advice is looked upon with suspicion; and, again, the meter is blamed when the burner is at fault, upon the consumer finding more gas registered against him than he has reason to believe he has used. While I do not believe, as a general thing, in giving burners to the consumers, yet there are occasions when a few burners may be thus disposed of to our advantage; and I certainly think it would be good policy to supply all classes of burners at cost price. Though we may not always succeed in persuading consumers to follow our advice, we must continue to give it; hoping it will bear fruit some day.

The principal duty and the best policy of gas suppliers, whether companies or corporations, is to sell gas at the lowest possible rate. In many cases local authorities are not doing this; for if you refer to the last returns presented to the House of Commons, you will find by the Local Authorities' return that many of them are handing over to some other spending department a large amount of money, being surplus gas profits. I have worked out the payment made by fifteen of the Local Authorities per 1000 cubic feet of gas accounted for, but not including gas used at the works, and the figure varies from 1·41d. to 11·74d.; the total payment being £177,755, and the gas accounted for 11,518,520,000 cubic feet—giving an average payment of 3·72d. per 1000 cubic feet. Surely if this payment is right, it ought to be made on some principle as to the percentage of profit that should be handed over; but, in my opinion, the payment of these large sums of money for the relief or otherwise of rating are wrong in principle. Each department should stand on its own bottom, and if any profit is made after paying all charges, such as interest and sinking fund, it should go to a reserve fund, and the price of gas reduced to its lowest point; and in case of any year's income not reaching the amount required to pay all charges, the difference could be made up from the reserve fund.

If local authorities have erred in this respect, I fear we cannot say that gas companies have invariably studied the interests of their consumers; for cases have arisen from time to time showing that gas companies have not always been satisfied with paying maximum dividends, but have been over-anxious for an extravagant reserve, and a large surplus of undivided profits. They appear to forget that they have a duty to carry out to their consumers, as well as to the shareholders. The sliding scale has been of great benefit; but I think that in many cases the standard price fixed was too high.

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In this age of competition, however, the suppliers of gas, whatever may be their rights, ought not to require any hard-and-fast rules as to what profit they should make, but should, as far as is consistent, enter into the spirit of the times, and sell the article they supply at such prices as to defy the honest competition of any other method of artificial lighting. One class of property the suppliers of gas have almost ignored—viz., cottage property. If the occupiers of this class have wanted light, they have been compelled to use either candles or a cheap form of oil-lamp, for the simple reason that they could not afford to pay the expenses attendant upon having the internal service-pipes laid, and fittings put up. Even if the service-pipe is laid, and the fittings provided by the landlord, many are debarred from using the gas from the fear of their inability to pay the quarter's account, although they would not find any difficulty in making weekly payments to an equal total amount. Until quite recently, no one seems to have considered whether this class of customer was not worthy of more attention. In common with some others, I think he is. The oil man who waits upon him every week thinks he is well worth attention; and why should not we? True, we cannot supply gas in the primitive style that oil is sold; but I certainly consider we may make the supply of gas to cottage property a profitable source of business. But this can only be done, in my opinion, by laying on the supply of gas free, and by adopting the system of weekly payments for the quantity consumed. This plan I have recommended to my Directors for their adoption; for, in common with many other towns, we have a large proportion of the population who use oil or some other illuminant than gas, and the majority of whom we should be glad to have as consumers.

In the excellent paper read by Mr. Dalgliesh before the Manchester District Institution on Dec. 3 last year,* he proved how the percentage of population supplied with gas differs in many towns; his table showing that the number of inhabitants using oil or other illuminants varies from 0 to 81 per cent. Whether this is to be relied upon or not, we all know that a very large number are not users of gas who might and would be if there were an easy system of supply and payment. With this end in view, I should be prepared to supply any occupier of a cottage with gas on his application to be placed on the weekly system of payment, and would, where necessary, supply and fix certain plain fittings on hire at a small weekly rental; but the occupier or landlord must pay for the internal pipes. This should certainly be done by the landlord; so that beyond the weekly rent of the meter and fittings, the consumer would have nothing at all to pay for except the gas used.

* See "Reports of Gas Associations for 1887," p. 316.

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The meters would be inspected and the money collected weekly by the inspector; the quantity of gas used and the amount paid to be entered upon a card provided for the purpose. In no case would the consumer be allowed to owe for more than two weeks' gas; and if the amount was not paid in the second week, the inspector would stop the supply until such time as the arrears were paid. So long as this system is carried out, it does not appear to me to be a matter of much consequence whether you adopt this plan, or the plan of making a fixed charge for the summer and winter weeks, and making the adjustment at the end of each quarter. Or perhaps some may feel inclined to try the system of prepayment by an automatic meter, on the plan explained to us at our last meeting by the inventor, Mr. Brownhill (see *ante*, p. 42). I do not think the expense of working either of these systems would vary very much. At first, the summer consumption of this class of consumer would be very small; but I have no doubt a great deal could be done to increase this by introducing small cooking-stoves or boiling-burners, the advantages of which would soon be appreciated by the users.

Where the fittings are on hire, it is my intention that they shall be inspected at certain times in the year; and anything found wrong should be put right. It would be a great advantage to both ourselves and our consumers generally if we had power to inspect their fittings, for what a number of complaints it would prevent. It is the custom of many gas suppliers to lay the service-pipe 30 feet from the main at their own expense, providing it does not enter upon private property; but the occupier has to pay for the portion upon the private property, and also for the main-tap and the time occupied. I think this might be altered with advantage to intending consumers, and at little extra expense to ourselves, so that the whole work would be done free of expense where the total length of service did not extend (say) 30 feet from the main.

Another matter which is a continual source of trouble is the system of deposits. With a view to obviate this difficulty, I think it would be well to offer those from whom a deposit is considered necessary the option of prompt monthly payments for the gas used. Of course, where the alternative is not accepted, the deposit should be insisted upon.

In conclusion, I would ask you to give these matters, which I have put before you in a somewhat imperfect manner, your earnest attention. My desire is that each and all of us managers may be prepared to maintain the supremacy of gas as an artificial illuminant so long as it is generally considered worthy of occupying that position.

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Subsequently the members were driven through the main portion of the town, to enable them to view some of its many interesting features. Mr. Commans courteously arranged to conduct the party through the extensive bathing establishment, of which he is one of the Directors. The Roman Remains, the Pump-Room, and the various suites of baths (the whole of which are the property of the Corporation), excited much interest, and thoroughly repaid the members for the time devoted to the inspection. An adjournment was then made to the Christopher Hotel, where a dinner had been arranged for by the Directors of the Gas Company as a fitting termination to the day's engagements. Mr. Commans occupied the chair, and Alderman Bartrum the vice-chair; and the proceedings were marked throughout by the greatest cordiality.

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MANCHESTER INSTITUTION.

QUARTERLY MEETING, MAY 19.

This Meeting was held at Northwich—the centre of the great Cheshire salt district; and, as usual with the second meeting of the year, was essentially of a holiday character. A large number of members and visitors assembled at the Central Station, Manchester, and proceeded by the 11.35 a.m. train to the town selected as the centre of the day's excursion. At the Northwich Station, Mr. S. S. Mellor, the Manager of the Northwich Gas-Works (accompanied by a number of gentlemen who had found it more convenient to travel by other routes than that arranged for the general body) was waiting to receive the party; and, vehicles being in readiness, a start was at once made.

The first halt was at the Crown and Anchor Hotel, for luncheon; after which the company drove to the Marston Old Mine, which is one of the most noted of the local show places. It is the largest and oldest of the mines of the district. Access is gained to it by means of a shaft 112 feet deep—a considerable proportion of which is through a bed of rock salt reputed to be no less than 100 feet thick. The mine has been worked for many generations, and the galleries extend for miles. The rock has been got out for an average depth of 15 feet; and many of the roads are so wide that half-a-dozen omnibuses could be driven abreast without danger of collision. Large pillars have been left in the working; but between these are immense expanses of perfectly flat roof, wholly unsupported. The rock is, however, so hard and free from faults that falls of roof, such as are common in coal and other mines, are unknown. Messrs. Fletcher and Rigby, the owners of the undertaking, had made special provision for the reception of the party, who were conducted through large expanses of the old workings, saw the processes of getting the salt (including the firing of several shots), and were treated to a special illumination of the mine. Above ground they witnessed the process of manufacturing salt, by evaporating brine pumped up from shafts sunk for this purpose, and drying the salt which had been deposited in the evaporating-pans in kilns heated to a high temperature. It was by-the-by, remarked that the temperature of the mine varies but

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slightly; and that, without special ventilation, the thermometer remains at from 50° to 51° Fahr. all the year round.

After leaving the works the party drove to the bank of a lake, which is continually increasing its area owing to the encroachments of the River Weaver from the sinking of the land resulting from the brine pumping. Here a little steamer was waiting to take them down the Weaver to the Anderton hydraulic lift, by means of which canal-boats are raised and lowered between the Weaver and the Mersey and Trent Canal. The canal is 50 ft. 4 in. above the river; and the two caissons in which the boats are lifted are each 75 feet long, 15 feet wide, and 5 feet deep, weighing when loaded 240 tons. The lift is so arranged as to do its work with the least possible expenditure of power. When the caissons have been closed, the hydraulic accumulator is set in operation for a few seconds, and raises the one caisson and lowers the other to the extent of a foot. By an automatic arrangement, a portion of the water in the ascending caisson is then syphoned out; and its weight being thus reduced below that of the descending one, there is no need for the expenditure of more force until the caissons come within a foot of their new positions. The accumulator has then to be again operated to overcome the resistance offered by the water in the tank at the river-level, which, of course, tends to buoy the descending caisson up. The extremely simple and yet ingenious nature of the whole operation was much admired. Returning to the steamer, the party then made a trip up the Weaver, past the town of Northwich, to Hartford Locks, where the navigation has been greatly improved by putting in new locks, and where an old lock (one of a series now dispensed with) is being taken out. Captain Saner, C.E., Engineer to the River Weaver Navigation Trustees, accompanied the party in the excursion by the steamer, explained the various works, and showed the visitors other kindness.

When Northwich was again reached, tea was taken at the hotel already named; and after tea a short business meeting was held.

The President (Mr. T. Duxbury, of Darwen) occupied the chair; and in the first place the minutes of the last quarterly meeting—held at Manchester in March (see *ante*, p. 44)—were read by the Honorary Secretary, Mr. Harrison Veevers, of Dukinfield. They were confirmed on the motion of Mr. W. R. Chester, of Manchester, seconded by Mr. J. Dalgliesh, of Glossop. The next business was to elect a new member—Mr. Alfred Thomas Fletcher, the Manager of the gas-works at Leigh. Then came votes of thanks to the gentlemen whose kindness had contributed so materially to the success of the day's meeting. The President moved a resolu-

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tion which included Messrs. Fletcher and Rigby and Captain Saner—the former for their kindness in permitting the visit to the mine and illuminating it for the occasion, and the latter for placing the steamer and himself at the Institution's disposal. Mr. J. Chadwick, of Oldham, seconded the resolution, which was carried by acclamation. Thanks were also very heartily accorded to Mr. Mellor and to some of his local friends, who had contributed to the success of the gathering. This proposition was moved by Mr. Veevers, seconded by Mr. Chester, and supported by the President —all members of the Committee charged with the arrangements for the excursion, and therefore specially qualified to speak of the assistance which the local gentlemen had rendered.

After this some of the party wandered about the town, and especially noted the singular inclination which the subsidence of the land has given to many of the buildings. Some paid a visit to the neatly-appointed little works of which Mr. Mellor has charge, and were especially interested in an inspection of the means which he has adopted for jointing the mains in the district. How rapid is the subsidence in some cases may be judged from his statement that one main has been raised 15 feet in five years; and that the leakage, which is now 20 per cent. has been as high as 35 per cent. of the year's make—about 25 million cubic feet. The loss is checked to some extent by the use of india-rubber in the jointing of the mains, and by the occasional employment of expansion joints; but breakages of mains and drawn joints are sources of constant trouble and vexation.

The return journey was commenced at 8.25 p.m., and Manchester was reached in an hour. Thus ended a very enjoyable day. Much of its success was owing to the beautiful weather; but credit is certainly due to Mr. Harrison Veevers and the members of the Committee, for the excellence of their arrangements.

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NORTH BRITISH ASSOCIATION.

ANNUAL MEETING, JULY 26 & 27.

This Meeting was held at Glasgow; the business portion being transacted in the Hall of the Philosophical Society, Bath Street—Mr. DAVID TERRACE, of Dawsholm, Glasgow (the President), in the chair.

REPORT OF THE COMMITTEE.

The SECRETARY (Mr. R. S. Carlow, of Arbroath) read the annual report of the Committee, in the course of which it was stated that the remit on "The Best Standard Burner for Scotch Gas" had been under consideration; and it had been resolved to place the results of the testings of the burners in the hands of Mr. Geo. R. Hislop, the Convenor of the Sub-Committee on the question; and he had undertaken to prepare a paper upon the subject for the meeting. The report also referred to the endeavours resolved upon a year ago to institute an investigation into the purification of gas in closed vessels. Arrangements could not be completed in time to admit of a report being presented to the meeting; and it was recommended that the Special Sub-Committee which had been appointed should be requested to continue in office for another year. During the year the Benevolent Fund had been drawn upon to the extent of about £20. After dealing with some other matters, the report stated that it had again been considered advisable to postpone taking definite action in reference to the Murdoch Memorial. There had been subscribed to the Memorial Fund the sum of £287; and the Committee intended to make further efforts to increase this amount. Mr. Robb, of Haddington, had made an offer to the Association to present to it his bound volumes of the *Journal of Gas Lighting*, &c., on condition that a "home" should be provided for them in Glasgow or Edinburgh. Owing to this condition, the Committee had very unwillingly been compelled to decline the proposed addition to the property of the Association.

The report was unanimously adopted.

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The Roll of the Association.

The Secretary next read extracts from the minutes of the Committee meeting held prior to the general meeting. They showed that the following gentlemen had ceased (by resignation or otherwise) to be connected with the Association :—Ordinary members—Messrs. J. Adamson, Anstruther; A. Dougall, Hull; J. Gibb, Armagh; J. Burden; J. Morton, Muirkirk; P. Blair; and J. Stiven. Extraordinary members—Messrs. R. Brown, Lanemark (deceased); and C. T. Grant, Glasgow. The members of the Association number 166 ordinary members, 57 extraordinary members, 12 associates, and 4 honorary members; but deducting those resigning, &c., the numbers respectively are 159, 55, 10, and 4 —total, 228. Adding to these 10 ordinary, 3 extraordinary, and 4 associate members applying for admission (as per following list), there is a total of 245 members, including 4 honorary members.

Admission of New Members.

The Secretary also submitted applications from the following gentlemen, who were admitted :—

ORDINARY MEMBERS.

Ballantyne, J.	Gas-Works,		Rothesay.
*Bell, A.	„	„	Peebles.
Boyd, T.	„	„	Lennoxtown.
Cheyne, D.	„	„	Mountain Ash.
Donaldson, J.	„	„	Lochwinnoch.
Laing, W.	„	„	Dysart.
M'Donald, J.	„	„	Denny.
*Mitchell, D.	„	„	Newbattle, Edinburgh.
Ross, G.	„	„	Stonehaven.
Walker, A. B.	„	„	Spittal, Berwick.

* Transferred from Associate List.

EXTRAORDINARY MEMBERS.

Brown, T. M., Lanemark Colliery	Lanemark.
M'Crae, A. B., Colliery Agent	Monifieth.
Morrison, J., Newbattle Colliery	Dalkeith.

ASSOCIATES.

Cameron, J., Jun.	Gas-Works,		Tradeston, Glasgow.
Edwards, W. A.	„	„	Brechin.
Robertson, H.	„	„	Broughty Ferry.
Ruxton, W. M.	„	„	Arbroath.

Appointment of Office-Bearers

Messrs. J. Cameron, Glasgow, and A. Mackenzie (Edinburgh), who had been appointed to scrutinize the ballot-papers, gave in

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their report as to the appointment of office-bearers for the ensuing year, as follows:—

President—George R. Hislop, Paisley.

Vice-Presidents—Samuel Stewart, Greenock, and Robt. Robertson, Bathgate.

Secretary and Treasurer—Robert S. Carlow, Arbroath.

New Members of Committee—J. M'Gilchrist, Dumbarton; J. Adam, Pollokshaws; and T. D. Hall, Montrose.

Auditor—D. Bruce Peebles, Edinburgh.

Mr. HISLOP: Allow me to thank you all for placing me in the President's chair for the next twelve months. I was inclined to shrink from the responsibility of conducting the affairs of the Association for the coming year. But I must yield to the powerful influence of my friends; and I have to thank you for so unanimously returning me to that position. I shall endeavour, to the best of my ability, to discharge the duties devolving on me as President; and I hope the interests of the Association will not suffer in my hands. I have already been President twice; so that this makes my third election to the presidential chair in twenty years. I was anxious that the duties of this responsible office might have fallen on some other member; but I have yielded to the request of the Association, and I thank you for the honour you have conferred upon me.

PLACE OF NEXT MEETING.

It was decided to hold the next annual meeting in Dunfermline.

AUDITOR'S REPORT.

Mr. D. B. PEEBLES (Edinburgh), the Auditor, in submitting the accounts, said, as there were a good many details which would appear in the annual report, he would confine himself to giving a general outline of the financial position of the Association. In the General Fund the charge amounted to £163 11s. 10d.; and there was a balance of £12 14s. 10d. due to the Treasurer. So that there was no bank account in connection with the fund. With regard to the Benevolent Fund, there was a balance of £150 at the bank. There had been several sums paid to different persons whose cases were brought under the notice of the Association. The charge there was £200 14s. 10d., which was balanced by the discharge; leaving, as he had said, a balance of £150 at the credit of the fund. Then there was the Research and Investigation Fund. The charge was £83 18s. 9d.; the cash in the Treasurer's hands, £3 1s. 5d.; and the balance in the bank, £46 10s. He concluded by congratulating the members on their choice of a Secretary, as the books were clearly kept, and all the accounts properly vouched.

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A hearty vote of thanks was accorded to Mr. Peebles for his trouble in auditing the accounts from year to year.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—I thank you for the honour conferred upon me in electing me to preside over your deliberations at this our Twenty-seventh Annual Meeting.

There are now no fewer than nine similar Associations to this in Great Britain. Three of these are what may be termed "National," and six "District" Associations. These, and others on the Continent and in America have all sprung into existence since the year 1862, when the North British Association was instituted. The kindred Associations are doing good work in holding meetings, and otherwise disseminating very valuable information; each benefiting the other by publishing their reports, which are found of great service in our every-day work and transactions.

Taking our "Statistical Reports" as the basis of information, together with that from other sources regarding the gas supply of Scotland, I find that the make of gas in the year 1883 was about 6008 million cubic feet, and in last year (1887) about 7133 millions; showing an increase in five years of 18·7 per cent.

Although, in one sense, the process of gas manufacture may be said to be similar in its essential features to that so freely given to the world by Murdoch 80 years ago, it must be acknowledged that Science has greatly developed his ideas. Who, even ten years ago, could have foreseen that triple the carbonizing work would be done with the same floor-space in the retort-house, and that three times the illuminating value would be obtained from the same quantity and quality of gas? These vast improvements are due to the regenerative, or, as it is sometimes called, the recuperative principle—*i.e.*, regaining and utilizing the heat that otherwise would have been lost in the old open furnace, and in the combustion of the open gas-flames respectively. It is principally due to these and other such inventions, that coal gas will hold its position in the supply of artificial light for many years to come.

I need not recapitulate the many advantages derived from the use of regenerative retort settings; but I may say that the expectations formed when the system was introduced have been realized. The only development that I will notice here is the increase in the size of the retorts with the same oven space. The benefit that accrues from this is shown in that each retort can now carbonize 22 cwt. of coal per day, in the 21 in. by 15 in.

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size, as against 18 cwt. in the 18 in. by 13 in. size. Before this system was applied, it was only possible to carbonize 14 cwt. per retort per day in the 18 in. by 13 in. size. If you reckoned that eight retorts are now placed in one oven where there were only four to six in the old furnace arrangement, and that half the fuel is saved, you can estimate the great amount of carbonizing power and economy attained. Doubtless, in the course of a few years the system will be more generally adopted than it is at present. There are about fifteen gas-works in Scotland, where the retorts are heated by this method, making about 3410 million cubic feet per annum, equal to 47·8 per cent. of the total manufacture; and if we take into account those works which contemplate introducing the new furnaces, nearly 60 per cent. of the gas produced will in a short time be manufactured in retorts heated by regenerative furnaces.

Judging by the frequency with which the subject of choked ascension-pipes is discussed, it would appear that these are always to be a source of annoyance. My experience is that stopped pipes are not more numerous with the regenerative settings than with the ordinary furnaces, although the temperature of the retorts is much higher. Pipes will choke in any setting, if the retorts are not evenly charged, and the liquid in the hydraulic main kept thin, to give as slight resistance as possible to the issuing gases.

The question as to the requisite temperature to which the gas should be brought in the condensers, in order to secure its proper after-treatment in the scrubbers and purifiers, is a most important one. The ever-changing temperature of the atmosphere, and the varying quantities of gas made, necessitate having a ready means whereby to regulate the cooling power. This requires constant supervision. I find that a continuous temperature of about 65° Fahr. is the best for the gas at the outlet of the condensers; but, although we may be able to control the temperature up to this point, it is next to impossible to guard against the effects of low temperatures on the scrubbers, purifiers, and gasholders; also of very severe cold on the street-mains, necessitating the use of increased quantities of high-class cannel, in order to maintain a uniform quality of gas. To show how the different qualities of coal vary according to the seasons of the year, I may mention that when the temperature of the air is normal—say, 60° Fahr. —we can use coals, with good heats (say, about 2000° Fahr. in the retorts), and three-hour charges, giving an average illuminating power of 23 candles to maintain the standard quality of 23 candles; but when the temperature falls to 45° and 30°, it is necessary to use coals that will yield gas of 24 and 25 candles

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respectively at the normal temperature, in order to keep up the standard. These figures form a great contrast to those where 16 to 18 candle gas is supplied, as, in these circumstances, the average quantity of first-class coal used in midwinter does not exceed 5 per cent., and not more than 2½ per cent. on the yearly quantity; whereas, when 23-candle gas is supplied, it is found that in midwinter 20 per cent. of the higher class cannels are required, and about 11¼ per cent. in proportion to the yearly quantity. This proves that the higher the quality of the gas, the more it is subject to depreciation from atmospheric influences. It is, therefore, evident that great portions of the luminous properties of the gases are deposited in the apparatus between the retort and the consumer; the quantity depending on the quality of the gas supplied, and on the degree of cold to which the gas is subjected; and unless the extent of this is ascertained by frequent photometric testings daily, the consumer cannot be supplied with gas of uniform quality.

I need scarcely say that the scrubbing power should be sufficient to free the gas from ammonia; but it should not be taken for granted that, because there are no indications of this impurity at the outlet of the scrubbers, the gas must necessarily be free from ammonia when stored in gasholders. It is quite possible to have gas free from ammonia at the outlet of the scrubbers, yet containing ammonia in considerable quantity at the outlet of the purifiers, as a chemical reaction may take place, probably due to a decomposition of cyanides by the lime used in purification. When this occurs, means should be taken to absorb the ammonia before the gas enters the holders. Very wet lime is conducive to more, rather than less, ammonia being formed. The hydrate should not contain more moisture than 50 per cent. of its weight.

The purification of gas in closed vessels by means of the foul gases contained in itself, so far as its application to practical work is concerned, is still untried. It is unfortunate that arrangements have not been made to investigate the system advocated by Mr. William Young, who read a paper, and ably demonstrated his process at our last meeting. Apparatus on the Claus system has been erected at Belfast sufficient to purify gas from 250 tons of coal per day. This is expected to be in operation during the ensuing winter; and the results will be looked forward to with much interest. These two systems are now before the gas world; and I need only refer you for a full description of them to the past records of the various Associations. I trust that, before the expiration of another year, apparatus will be at work, showing the operation of Mr. Young's process on a practical scale; so that we may be in

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possession of actual data in regard to the cost of plant and working, and other necessary information, and also the relative advantages likely to be derived from employing each system.

The use of oil as a substitute for coal in gas making has again been receiving attention; the very high luminosity of the gas appearing to be considered as one of its principal advantages. This, however, is only one side of the question; and it may be conceded that we, as producers of light, are alive to the merits, or otherwise, of employing oil in our manufacture. The system may be suitable where a supply of coal gas at a moderate price is not available; but it will not be generally adopted until the "steady" price of the raw material makes it more profitable to use than coal. Even then the introduction of oil would require to be very gradual, as its use in gas-works, if only to a limited extent, would tend to greatly raise the price. The gas from oil is generally credited with being of 60-candle power. This may be the case when made and tested on the spot; but when it has to be stored and distributed in the usual manner to towns, the results may be vastly different. From practical tests made on oil gas after storeage (the temperature of the gas being 48° Fahr.), I found the quality to be 37 candles, per 5 cubic feet, with a consumption of 2¾ cubic feet per hour with one of Bray's No. 4 union-jet burners. When the same gas was tested with a No. 3 burner, consuming 2 feet per hour, the quality was found to be 29 candles, calculated to 5 feet per hour; making it apparent that the use of small burners is as injurious to gas of this comparatively high quality as to gas of lower illuminating power. The question arises: Is 60-candle power gas worth twice 30-candle gas, or thrice 20-candle gas? I think not. The greater pressures at which the higher qualities have to be consumed, in order to get the best photogenic results—say, from 10-10ths to 14-10ths—eject the hydrocarbon particles from the burner into the atmosphere so rapidly that a quantity of them pass off unconsumed; whereas with the lower qualities consumed at lower pressures—say, 5-10ths or 4-10ths—a greater proportion of the light-giving properties areutilized.

It is one of the most difficult problems how to get consumers to use the gas supplied to them properly; this being at the root of most of the complaints they make about the light obtained. It should be more generally known that the amount of light emitted depends as much if not more) on the means of consumption as on the inherent quality of the gas. I trust some of the papers to be read to-day will touch on this subject. So much has already been said and written on the great waste of gas, and still so much has been left undone that the field for improvement in this respect

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is nearly as wide as ever. Until it is in the power of the companies and corporations to take charge of the gas supply from the meter to the point of consumption, nothing of any benefit is likely to accrue to the consumer.

In testing several of the devices intended to improve the ordinary open gas-flame, I found no increase in the luminosity per cubic foot of gas consumed from that given by the union-jet consuming 5 feet per hour at 5-10ths pressure. The inventors of most of these devices start on a wrong basis by first using small burners, thus forcing the gas through minute apertures at high pressure, and then baffling the flame at the point of ignition, instead of regulating the pressure, and using the gas through a large burner. Although apparently a very simple matter, it seems a very difficult one to be understood, or acted upon, by the average consumer—that any ordinary burner (union-jet or batswing) provided it be the size suitable for the space to be lighted, is as good as any other (open flame), if used at the proper pressure, for the quality of the gas. When consumers cannot adjust the burners and pressure, they should, in order to obtain a good and economical light, use gas-governors (where the fittings are suitable), or burners containing within them the means for regulating the supply.

From the results of about 100 tests made on 23½-candle gas, to ascertain the relationship between the durability test and the candle power, I found (with a 5-inch flame from a single-jet burner, consuming, at 0·59 inch pressure, 1·204 cubic feet of gas per hour corrected for temperature and barometer), that the durability in minutes, divided by 2·117, gave the quality in candles. About half the number of tests ranged to 1·39 candles above, while the remainder varied to 1·36 candles below, the average results obtained by the Letheby photometer. Considering that candles themselves may vary to a similar extent, these results would show that within certain limits the readings from the durability test may be relied on when the same class of coals and other conditions of manufacture are constant. Using the same divisor for other gases, however, I found variations of 3 to 4 candles above the actual quality, which can only be accounted for by altered conditions of manufacture. From these data we may infer that to use the durability test as a standard, it would be necessary first to obtain a factor from a series of experiments similar to the above, with comparative daily readings over a long period. We may also conclude that the same sources of error present themselves in the use of such appliances as the jet photometer.

Comparing the results obtained by testing seven types of regenerative lamps with various qualities of gas, I find the proportion of

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increase in light from that given by the usual test burner varies from 100 to 150 per cent. The following table gives the results of some of the tests made:—

The Illuminating Power of Various Burners (the Regenerative Lamps being at an Angle of 45° to the Candles).

No. 8 Union-Jet Burner (for Cannel Gas), consuming 5 ft. per Hour at 5-10ths Pressure.	No. 8 Union-Jet Burner (for Common Gas), consuming 5 ft. per Hour at 8-10ths Pres.	London Standard Argand.	Regenerative Lamps. "A" Series.	Regenerative Lamps. "B" Series.
25·18	—	—	49·96	—
23·50	—	—	58·29	—
22·97	—	—	—	55·02
14·02	15·69	17·39	30·98	—
12·74	14·86	17·40	27·78	—
11·52	13·81	16·35	26·91	31·81
7·02	—	13·34	—	29·45

It is generally conceded that the different qualities of gas ought to be tested in the burners best adapted to yield the highest photogenic results. Where there is no clause in the Gas Act determining the mode of testing, we may soon be having it reported that the gas supplied to certain towns is of abnormally high power—say, "50-candle gas," as shown by the photometer with the best burner, or, as some Acts put it, "the most suitable burner." When the quality of gas is stated as of such a candle power, it should, by way of comparison to that supplied by other towns which have to use the prescribed, or recognized standard burner, be mentioned as tested by a certain defined burner. This is now rendered all the more necessary on account of the introduction of incandescent burners and regenerative lamps.

In the Gas Annexe of the Glasgow International Exhibition, the opportunity is afforded us of inspecting some of the latest novelties, and some of the best apparatus, in use for lighting, cooking, heating, and motive power. It will be observed that gas is still able to hold more than its own for the brilliancy and applicability of the latest forms of the light, although confronted on nearly every hand by its would-be rivals—oil and electricity. Gas lighting is applied wherever reliability is a *sine quâ non;* and it is therefore ever ready to take the place of, and, when need arises, make good the defects of its luxuriously nurtured brother. The Machinery Department will also be of special interest to the members; and there, as well as in a great many other departments, the gas-engine—in its various forms—

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plays a very important part. Altogether we have reason to congratulate ourselves on the great success of the exhibits where gas is employed, as well as to the many useful purposes to which it so readily adapts itself. Its motto is always: "Ready, aye ready."

Mr. A. MACPHERSON (Kirkcaldy) proposed a vote of thanks to the President for his excellent address.

Mr. W. KEY (Tradeston, Glasgow) seconded the proposition, which was unanimously adopted.

The PRESIDENT expressed his thanks to the members for the compliment.

The reading of papers was then proceeded with. They were taken in the following order:—

GAS-BURNERS FOR PHOTOMETRICAL PURPOSES.

(REPORT ON THE REMIT ON THE BEST STANDARD BURNER FOR SCOTCH GAS.)

By GEO. R. HISLOP, of Paisley.

The consideration of this subject is the result of an obligation which I have come under to your Committee, to dispose of a remit to a Special Committee of this Association appointed some three years ago, and of which I have recently been made a member, to determine "The Best Standard Burner for Scotch Gas." The title of this paper may justly excite surprise, and exact the enquiry why light is needed on such a subject, after an experience of three-quarters of a century of practical lighting by coal and cannel gas.

It cannot be denied that in the midst of abounding light on all possible questions affecting gas manufacture and distribution, we have been comparatively slow to discover the laws which regulate the elimination of the highest lighting power of different qualities of coal and cannel gas. Inasmuch as it is just within these last few years that we have been able to hail some dawning light, and now we have but entered upon a new era in the history of gas illumination, by the discovery of means whereby we are now enabled to realize, approximately at least, the highest possible lighting power of the gas. I refer to low-pressure combustion, and the utilization of the radiant and conducted heat of such combustion in the so-called regenerative gas-lamps. These are, moreover, entirely a new departure in gas lighting. But with respect to the common form of burners, while various improvements or devices have been introduced for the purpose of reducing to a minimum the pressure at the point of combustion, and with a corresponding increase in light—chief amongst which may be mentioned the ingenious automatic "Needle" governor burner—no attempt has been made to show that intensity is

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affected in any way under any other condition. The fact is well established that a low velocity *versus* slow combustion of the issuing gas from a burner, has an important effect upon the value of the light afforded by any quality of gas; but no definite rule has ever been laid down to enable anyone to order or procure a burner or burners exactly adapted for any particular quality of gas. Not one word of reference is ever made to the angle of the impinging jets or to relative dimensions of flame in relation to quality of gas, which I maintain are indispensable conditions. A flame even at 5-10ths of an inch pressure may be unduly spread; and this, in the case of gas of poor quality, is to expose it to over-oxidation, and the cooling effect of the nitrogen of the atmosphere, with its consequent reduction of light.

I purpose in this paper to define certain principles in the construction of burners, which have hitherto been disregarded generally, but which I hope to show are all-important in their bearing upon the quality of the gas. It is not my intention to do more than touch upon the subject of burners for domestic and public lighting; but simply to deal with the class of burners which we may or are compelled to employ under existing Acts of Parliament for the purpose of determining the highest illuminating value of the gas we deliver to the consumers, consistently with the conditions laid down in said Acts of Parliament. It will be borne in mind that one invariable condition is that "the pressure at the point of combustion shall be equal to 5-10ths of an inch;" hence all my results must necessarily be based on this hypothesis.

That our information is defective on the subject of suitable burners for testing various qualities of cannel gas will, I feel certain, be testified to by all careful experimentalists and gas managers who have to deal with gas of 20-candle power and upwards, and which is invariably tested by means of union-jets. Moreover the fact that this Association and your Committee have realized the difficulty, will itself justify the enquiry. Indeed I confess that for many years it has been a matter of considerable concern to me how or where to find burners of proper construction for different qualities of gas. When found it was purely accidental, and they were consequently prized as if worth ten times their weight in gold. Since having no definite theory regarding the construction of such burners, to order their manufacture was, of course, out of the question. I have in my experience, therefore, tried to bring to proper condition by stuffing, in various ways, all sizes and forms of burners I have been able to lay my hands upon; but general failure has been the result. But why should I succeed when the construction of the burners tried was entirely at variance with

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the conditions requisite to develop the lighting power of the gas? In short, the orifices of all the burners were drilled at angles much too high for the quality of gas I wished to test. Nearly all burners manufactured have their orifices drilled at angles ranging between 45° and 60° (and that without regard, apparently, to the quality of gas at all); whereas the investigations and experiments I have carried out unmistakably prove that the angle at which the holes of a burner stand to each other have a remarkable influence upon the quality of the gas. Suppose we take 22¼-candle gas, the angle giving the highest intensity of light is 22°; but if the same volume (5 feet) be consumed at 45°, the illuminating power will be reduced to 19·71 candles, or 0·110 of a candle for each degree advanced; while the dimensions of the flame will have been altered from $3\frac{9}{16}$ inches high by $2\frac{7}{16}$ inches broad to $2\frac{9}{16}$ inches high by $3\frac{1}{16}$ inches broad. The table (on next page) will show similar results for all qualities of gas from 17·9 to 32·6 candles, advancing approximately 2 candles in quality for each series of tests.

In order to arrive at the results thus shown, I had specially made for the purpose of my experiments an extensive series of burners—consisting of sizes Nos. 5, 6, 7, and 8, drilled at the various angles up to 60°; but my experiments clearly proved that the No. 7 size afforded the best results for all qualities of gas. H ence I have given the results from that size of burners only. These burners were of iron, but carefully made, and without any stuffing or pressure-reducing medium save the smallest quantity of cotton-wool to prevent flaring, balance the flame, and give 5 feet per hour exactly at 5-10ths inch pressure. The illuminating power was carefully tested at the various angles, noting at the same time in each case the exact length and breadth of the flame. The latter I have not given on the table, as not being absolutely necessary; but the connection between the angles of the orifices, the dimensions of the flame, and the illuminating power, is very marked.

The principle which I have endeavoured to lay down is that, by the elongation of the flame as the scale of quality of the gas is descending, we secure what is equivalent to a reduction of pressure at the point of combustion, of something like 2-10ths of an inch, by increasing the period of incandescence of the carbon atoms, as anyone may readily suppose would be the result in an elongated flame; and this while fulfilling the requirements of the law in having the pressure at 5-10ths inch (no reference being made in the Acts to the dimensions of the flame). A properly elongated flame cannot be obtained from a jet drilled at the usual angles, unless consumed at a pressure far below the requirements of the Acts of Parliament, and then a smoky flame would result.

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Table of the Illuminating Power of Different Qualities of Gas Burned at 5·10ths Inch Pressure through No. 7 Union-Jets, Drilled at Various Angles.

Angle of Holes. Degrees.	Illuminating Power in Standard Candles.
(1)—17·90-Candle Gas.	
18	17·90
20	17·56
25	17·14
30	16·55
35	15·88
Difference for 17 deg.	2·02 cand.
Loss per degree . .	0·118 „

Angle of Holes. Degrees.	Illuminating Power in Standard Candles.
(5)—26·29-Candle Gas.	
20	24·20
25	25·45
28	26·29
30	26·08
35	25·55
40	24·51
45	23·78
Difference for 17 deg.	2·51 cand.
Loss per degree. .	0·15 „

Degrees.	Candles.
(2)—19·77-Candle Gas.	
20	19·77
25	19·17
30	18·45
35	17·73
Difference for 15 deg.	2·04 cand.
Loss per degree. .	0·136 „

Degrees.	Candles.
(6)—28·4-Candle Gas.	
20	25·36
25	26·33
30	27·51
33	28·40
35	28·05
40	27·19
45	26·54
50	26·00
Difference for 17 deg.	2·40 cand.
Loss per degree. .	0·141 „

Degrees.	Candles.
(3)—22·25-Candle Gas.	
20	21·94
22	22·25
25	21·86
30	21·49
35	20·98
40	20·40
45	19·71
Difference for 23 deg.	2·54 cand.
Loss per degree. .	0·110 „

Degrees.	Candles.
(7)—30·28-Candle Gas.	
20	27·42
25	28·22
30	29·25
35	29·60
37	30·28
40	29·70
45	28·93
50	28·12
Difference for 13 deg.	2·16 cand.
Loss per degree. .	0·166 „

Degrees.	Candles.
(4)—23·8-Candle Gas.	
20	23·29
24	23·80
25	23.69
30	23·09
35	22·48
40	22·18
45	21·27
Difference for 21 deg.	2·53 cand.
Loss per degree. .	0·12 „

Degrees.	Candles.
(8)—32·60-Candle Gas.	
30	30·27
35	31·20
40	31·87
45	32·60
50	31·66
55	30·80
Difference for 10 deg.	1·8 cand.
Loss for degree . .	0·18 „

Table of Angles affording the Highest Results.

18	degrees for	. .	17·90-candle	gas	
20	„	„ . .	19·77	„	„
22	„	„ . .	22·25	„	„
24	„	„ . .	23·80	„	„
28	„	„ . .	26·29	„	„
33	„	„ . .	28·40	„	„
37	„	„ . .	30·28	„	„
45	„	„ . .	32·60	„	„

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It will be observed from the table that the necessary angle for the lower qualities of gas increases rather slowly as compared with that required for the higher qualities of gas; and it will be obvious to all that, by ascending the scale of quality, a corresponding increase of angle and more direct impingement of the issuing gas, will be necessary to burn 5 feet and secure the highest results, which, as a matter of course, is just under the smoking point. Conversely, by descending the scale of quality, the angles must be reduced, and with this a gradually narrowing flame, till we should reach for the 5 feet consumption a round flame like that of a rat-tail burner—the diameter of the burner tip cup being, of course, narrowed with the narrowing flame. Thus the principles I have laid down may be represented by two lines drawn from a point, the point representing gas of the value of say 5 candles with a solid flame, and gradually diverging till representing the diameter of the flame of gas of the highest intensity, or say 32·6 candles at an angle of 45° (as per table), and which gives 3⅜ inches as the breadth of the flame (by 3½ inches high). Thus, in gradually rising or descending the scale of quality, I contend that the diameter of flame giving highest intensity for different qualities of gas will fall within these converging lines.

With regard to burners made on this principle for ordinary lighting, it will be necessary only to obtain them at angles of say from 5° to 7½° higher than those giving the highest intensity for photometrical purposes—depending upon whether for domestic or factory use.

I might have said much more upon this important subject, but I trust I have made sufficiently clear to you the principle upon which burners for all qualities of gas ought to be constructed; and if so I shall have discharged my obligation to your Committee to dispose of the remit "On the Best Standard Burner for Scotch Gas."

Discussion.

The PRESIDENT: I am sure we have all listened with great pleasure and profit to Mr. Hislop's paper. I should like him to tell us whether, when referring to the angles, the 30° meant off the vertical or off the horizontal.

Mr. HISLOP: Off the vertical line.

The PRESIDENT: It is important to know that, because you can read 45° either way; but you do not know whether the sharpness of 30° is one way or another.

Mr. W. FOULIS (Glasgow): I have been very much pleased with Mr. Hislop's paper. The experiments he has carried out are altogether novel—at all events, I have not before heard of any

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experiments showing the effect of the different angles at which the holes are drilled. It could scarcely have been anticipated that, in burning the same quantity of gas at the same pressure, the results would have been so different as Mr. Hislop's tables indicate, according to the angles of the holes. The information is very important; and, amongst other things, it shows that when statements are made respecting different qualities of gas, it is very necessary to know the conditions under which the gas is being burned. It also shows how important it is that consumers should attend to getting proper burners, so as to obtain the full value of light from the gas. I have no doubt that some of the burners which Mr. Hislop used were consuming gas in a way which, under ordinary circumstances, would not be objected to. It shows that those who are in charge of gas-works should endeavour to arrange, as far as possible, that consumers should have supplied to them burners which are the proper ones to use for the quality of gas that is being manufactured.

Mr. D. Bruce Peebles (Edinburgh): I should like to have had an opportunity of reading Mr. Hislop's paper before coming to the meeting, because I consider that the author has brought before us an altogether novel element. I do not think the angle of the apertures in gas-burners has ever been thoroughly considered in connection with the development of the illuminating power of the gas consumed. Long ago Mr. Stewart, of Greenock, called attention to the necessity for having burners of different sizes with certain pressures. Every burner, like every man, has its idiosyncrasy. With burners of the same size, and having the same holes, you will, by the alteration of pressure, so develop the illuminating power as to make the difference very perceptible, even with the same class of burner. I wish Mr. Hislop, while experimenting with the burners, had given the results at different pressures. This might have produced some slight difference in the flames. It is a clearly ascertained fact that every burner has a particular pressure which will bring out the greatest illuminating power of the gas being consumed. Mr. Hislop has opened up an excellent field of inquiry, which will doubtless lead to some practical result in the construction of burners. We are all more or less acquainted with the itinerant gas-burner man. Each has his own way of showing off his burners. One will hold up his white hand behind the flame and say, "See how pure the gas is made by my burner. You can see my hand through it." But it is the white hand reflecting the flame that imparts a certain amount of brilliancy to it. Another will hold a newspaper behind the flame and say, "See how transparent and beautiful the flame is. Why you can read the news-

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paper through it;" and so on. In this way the fault of the flame is preached up as a virtue. We hear such statements made to consumers, and they are led astray by them. Anything emanating from such a body as this, and from such a man as Mr. Hislop, will carry great weight amongst consumers. This is one of the most important subjects the Association could take up, because there is no doubt of the enormous waste caused by bad burners.

Mr. W. KEY (Tradeston, Glasgow): I understood that Mr. Hislop used iron burners; and I have to ask whether he tried burners of a larger diameter at the same angles, because I think the internal diameter has a great deal to do with the development of the illuminating power of the gas at the point of combustion. The ordinary iron burner has only a small internal bore. Mr. Bray's burner has at least double or treble the area; and the "Special" burner is still larger. I think the fact of the gas having to travel through the tube before it reaches the orifice at different angles has something to do with preparing it to be ignited and consuming the hydrocarbons. It is quite true, as Mr. Hislop has said, that gas managers and the public have been slow to develop in burners the highest possible illuminating power of the gas. Our President has told us that, by our present method of testing, 7-candle gas can be increased by the "London" Argand to 14-candle, and by a regenerative lamp to 28-candle power. This proves to my mind that there is something wrong, and that Mr. Hislop is justified in saying we ought to test gas with the best burner that can be obtained. He well deserves the thanks of the members. It is a credit to the Association to have a gentleman coming forward and discussing the effect of different angles on illuminating power; and if he were to add to this the various diameters of the burners, it would be something still further for us to reflect upon.

Mr. D. M. NELSON (Glasgow): For scientific purposes, I think every one will admit that Mr. Hislop's paper is pre-eminently excellent. The difficulty I see about it is that all the tests have been made with iron burners, which are now almost out of existence for ordinary use, and are therefore no guide to the ordinary gas consumer.

Mr. A. MACPHERSON (Kirkcaldy) said the paper was of such a novel character, that he felt unable to do justice to it without further study of its contents. If the members did not discuss the paper in the way they discussed other papers, Mr. Hislop would attribute it to the fact that the new departure was rather beyond their depth for a time. He hoped Mr. Peebles would set about the matter and produce burners suited for different qualities of gas.

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There was a great deal of truth in what Mr. Key had said about the size of the burner below the point of combustion. He had made experiments in this direction, and he had found that in the cylinder of the burner the carbon particles were raised to a high temperature before actual combustion; and, consequently, they were raised to a higher state of incandescence in the flame proper. The result was that more light was got from the same quantity of gas than otherwise would be got. If a stream of gas were passed through a long narrow orifice, the same amount of light would not be obtained as would be got were the gas passed through a wider channel before reaching the point of ignition. The angles at which the holes in a burner were bored was highly important. The great secret, no doubt, was the oxygenation of the flame. If there were too little oxygen, the gas passed off as soot, and took up its quarters on the ceiling. The consumer attributed this to bad gas, while it was the best of gas which was being destroyed. They could not be too particular in regard to burners, and it was the duty of every gas manager to enlighten the public upon the best way of consuming gas. He was of opinion that it would be a good thing if corporations and companies were to supply burners free.

Mr. J. M'Crae (Dundee): I did not hear the whole of Mr. Hislop's paper; but, judging from the criticism that has followed, I gather that the communication has been of a most unique character. We can therefore scarcely be expected, at a moment's notice, to freely criticize the figures, which have cost so much thought and research. I would endorse, with great earnestness the desirability of educating the gas consumer to use his gas, and not to abuse it. One serious difficulty which presents itself is this—that if a gas manager suggests a certain burner, or an alteration of the existing gas-burning arrangements, it is always attributed to a desire on his part to increase the consumption of gas. I am sure I express the sentiments of every manager when I say there is no one more satisfied at seeing gas properly consumed than the manager. This, however, can only be accomplished by using the best and most improved appliances. In passing along the streets of the various towns, we have evidence of the way in which gas is destroyed; and it makes a gas manager shiver to see the result of his handiwork thrown away, and to feel that in place of a good light there are large gas bills and general dissatisfaction all round. I hope to see the day when gas-burners will be handed to the consumers free; and not only this, but gas-burners suited to the various elevations of the towns in which they are to be used, because a burner that will do for a consumer on a level with the gas-works will be most

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unsuitable if used hundreds of feet above that level. I cannot say we have done this in Dundee; but I hope some day to make a move in this direction. Every town should be divided into zones, and for each zone there should be used a certain size and description of burner for ordinary consumers. Of course, for extraordinary consumers, extraordinary arrangements will have to be made. Now that Mr. Hislop has introduced this method, I hope it will be supported by the makers of burners. Any labour spent in this direction will not be lost; for it must result in satisfaction both to the seller and the buyer of gas.

Mr. HISLOP: I am greatly obliged to the members for their favourable criticism of my paper; and am specially pleased at the general expression of opinion that proper burners should be supplied to consumers. I have given much attention to this subject for a long time. I am glad to hear that opinion is ripening on this question; and I hope the new plan will be generally adopted. First of all, I have to thank Mr. Foulis. I am gratified to know that he thinks there are some good points in the paper; and this may encourage further investigation by other members. I hope this will be the result. The matter has long been in my mind, though I have not had time to go into it; and I felt sure there was more in it than has hitherto been considered of any value. I have many times observed that the flame of a burner under certain conditions would go up with the vibration even of a passing vehicle; and the result was to nearly double the amount of light given, although with a smoky flame. This was the first thing which led me to think over the subject, and to make out that there was something in the angle of the holes drilled in the burner. As to the burners being of cast iron, I have to explain that it is not very easy to make them with clay tips. When I learned that the Sub-Committee of the Association were engaged in a similar investigation as myself about three years ago, I gave it up, because we were both troubling Mr. Bray at the same time. However, I procured this extensive series of Nos. 4, 5, 6, and 7 sizes, in order that I might test the whole of the burners with the same gas at the same time; and this I did. Mr. Key made reference to the size of the barrel of the burner. I took care to avoid all forms of burners which might be considered as exclusive in the case of testing gas under Act of Parliament; and I took the plain burner. I did not attempt to test the gas at various pressures, as I found I could not do so without causing it to flare. About 5 cubic feet per hour was as much as I could get at 5-10ths pressure without flaring. Before we can go higher, we must have some controlling medium in the barrel of the burner; but I was careful

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to avoid anything that might be considered objectionable in the standard test-burner. I might have gone very much further with this matter, and said what was the best angle at which to consume the different qualities of gas at 3, 4, or 6 cubic feet per hour; but I contented myself with keeping strictly to my subject. Of course, I shall be glad if I have opened up a field for further investigation by any of the members; and I have not the slightest doubt that they will come to the same conclusion as I did—viz., that the angle of impingement of the jets has a great deal to do with the amount of luminosity afforded.

The PRESIDENT, in closing the discussion, said it only remained for him to ask the members to accord Mr. Hislop a hearty vote of thanks for his interesting paper, the elaborate tests in which must have cost him a great deal of trouble.

The proposition was carried by acclamation.

A YEAR'S EXPERIENCE IN THE MANUFACTURE OF SULPHATE OF AMMONIA.

By ROBERT COWIE, of Tillicoultry.

About two years ago, the Company with which I am connected decided to work up their ammoniacal liquor into sulphate of ammonia. They had from time to time received offers to take the tar and liquor for a year or term of years; but the amount offered was so small that they concluded it would be preferable to manufacture sulphate instead of selling the liquor. After having made a few experiments, it was decided to erect plant for the manufacture of sulphate; but before beginning its erection, I paid a visit to three gas-works where sulphate is made, to inspect the plant in use. I was well received by the managers; and all my questions were readily answered. The difference between their works and mine was very great indeed. Still, the information I obtained was very useful; and to these gentlemen I tender my warmest thanks. Here let me say that a remark which was made at the meeting of the Association held in Edinburgh in 1886, in the discussion on Mr. Dempster's paper, made me think there was an immense amount of worry and anxiety connected i the manufacture of these residuals. I thought I had quite enough of this without any more. However, the decree had gone forth, and I was determined to face it.

By this time the season was getting advanced; so, with as little delay as possible, buildings and plant were erected. I must

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say that for nearly six months I had plenty of worry and anxiety; many little things occurring which I did not foresee, and which were troublesome. The chief cause of trouble was not having a proper saturator, and working with acid made from pyrites instead of sulphur acid. By using acid made from pyrites I could not get a white salt; and a great deal of skimming was necessary. Besides this, the condenser and purifier were too small.

The first thing to give way was the saturator, which was cast ll in one piece, but was not of pure chemical lead, and consequently did not stand the acid for more than a month's working, when it was perfectly riddled with small holes. After this I had to work away as best I could with the box with which I had been experimenting, till a new one was made.

Let me here describe the plant I have been working with during the past twelve months. We procured a good second-hand steam-boiler (egg-ended), 20 feet long by 3 ft. 6 in. diameter, set in the usual manner. Placed near the boiler is the saturator—a wooden box lined with pure chemical lead, 15 lbs. to the foot, and all joints well burnt. Its dimensions are 4 feet long by 3 feet wide, with partitions running from side to side; the bottom of the saturator having an inclination, to allow the salt to be fished out during the operation. The saturator is connected to the boiler with a 12-inch wrought-iron tube, with stopcock and flange 2 feet from the top of the saturator, where it is bolted to the flange of the lead pipe which goes to the bottom of the saturator, along its whole length, and is perforated with a number of holes to allow the ammonia free exit into the acid contained in the saturator. Alongside the saturator is a wooden box, 3 feet long by 2 feet wide by 1 ft. 8 in. deep, lined with lead 4 lbs. to the foot. On the top of this box is placed the drainer, also lined with lead of the same weight, having an inclination to allow all the moisture to run into the box below. A few feet from the saturator is the storehouse, the floor of which is laid with lead 4 lbs. to the foot; the walls being of lead to a height of 4 feet. Above this are boards overlapping each other to near the roof. The floor has a fall towards one end, at which is placed a lead box to catch all drippings from the wet sulphate; also a false bottom of wood to preserve the lead from injury by shovels.

The operation of making the sulphate is as follows:—The liquor is pumped into a tank, 12 feet long by 4 feet square, above the boiler at one end, and allowed to settle. About 900 gallons are run into the boiler, and a fire is started under it. In about two hours ammonia begins to come over into the saturator, which is half filled with acid. The ammonia is arrested by the acid and formed into sulphate, which is fished out, and acid added as

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required; while the carbonic acid and sulphuretted hydrogen pass up a pipe at the other end of the saturator into the condenser, which is composed of a series of 4-inch pipes outside, on the wall of building. The last pipe is placed inside one much larger, through which runs a constant stream of cold water, which cools the waste gases before they pass to the purifier; which is much smaller than it would have been if I had had more space. It is only 3ft. 6in. long by 3 feet wide and 3 feet deep, and has two trays, which are covered with oxide of iron. The gas enters at the bottom, and passes up through the oxide. At the top of one of the sides is a 5-inch pipe connected with the flues of the boiler. When the lid of the purifier is on, the gas passes through this pipe, round the flues, and up the chimney. There is no disagreeable odour whatever during the operation. I may here mention that if the fire under the boiler becomes too strong, causing the saturator to throw off the gases very rapidly, we have a good deal of steam. This I intend to remedy by increasing the condensing power. It takes about 12 hours to distil a charge. I have not as yet used lime or soda to liberate any fixed ammonia, but intend doing so this year. When the charge is finished, the waste liquor is run off, and the boiler refilled on cooling. Should there be excess of mother liquor in the saturator, I have a coil of lead pipe round the bottom, in front of the partition, through which steam is blown, and the liquor evaporated. After cooling, the excess of salt crystallizes, and is fished out before beginning again.

With the plant I have just described, I may say I have had no trouble or worry. The men know now all that is required to be done. I have not employed any additional hands to look after it; so that no extra wages have been incurred. During our heaviest make, the apparatus is at work once, and sometimes twice every week, as we are fairly well off for storeage room for tar and liquor, including the boiler, which is no sooner emptied than it is filled again. Thus our sulphate making does not interfere very much with our ordinary work during the busy season.

From the 836 tons of cannel coal carbonized last year, I obtained 8 tons 17 cwt. of sulphate, or upwards of 23 lbs. per ton of coal. The following statement shows the result of our working:—

Sulphate sold, 8 tons 14 cwt.				£101	9	7
Do. in stock, 3 cwt., at 12s.				1	16	0
				£103	5	7
9 tons of acid.	£32	10	0			
5 tons of coke, at 6s. 6d.	1	12	6			
10 p.c. on capital (£100)	10	0	0			
				44	2	6
Leaving a surplus balance of.				£59	3	1

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The sulphate was all disposed of in the district—I had no trouble with it. The farmers who bought it brought their carts and bags with them to take it away. I sold as much as 3 tons 6 cwt. to one farmer; to another, 1 ton 8 cwt.; to another, 1 ton; and to others, quantities as small as 1 lb., 3 lbs., and 7 lbs., to be used for flowers and vegetables. Some of the farmers to whom I sold sulphate last year told me they were pleased with the results; and they have taken more than double this year.

The plant I have described is equal to the requirements of a much larger works than the one of which I have charge. It is not very costly; and it works well. I am aware that there is the continuous process by various makers; which no doubt would be preferred in large works, as perhaps better results are obtained. My Directors are pleased with the past year's working. I hope, if possible, to make it more profitable; and I shall be pleased to receive any information that will help me to make it so.

Discussion.

Mr. S. Stewart (Greenock): I have listened with pleasure to Mr. Cowie's paper; and, considering the size of his works, I have to congratulate him on his successful working. In large establishments we may get a few pounds more sulphate per ton of coal than he does; but I consider 23 lbs. very good. The clear manner in which he has described his plant, and the success of his operations, should encourage other managers to follow this method. We are very much indebted to Mr. Cowie for his paper.

Mr. G. R. Hislop (Paisley): We are also indebted to Mr. Cowie for the example he has set to managers all over the country. How often do we find great hesitancy on the part of managers to adopt new processes, although these would certainly result in greater economy. In this respect, we have to compliment Mr. Cowie on the fortitude and courage he has shown in venturing on the experiments described, and on the results he has achieved with his apparatus.

Mr. A. Bell (Pentland Oil-Works): I think Mr. Cowie's failure with his first saturator was not due so much to the impurity in the lead as to the way in which the lead was cast. I had one of these cast saturators; and I found that the lead was being eaten away by the acid. After a careful examination, I discovered that in casting the lead the temperature had been raised too high, and it became oxidized on the surface, and then was mixed in the casting. It was on the oxidized spots that the acid immediately acted. I had the oxidized portions cut out; and the saturator has worked successfully for the past three years. The ordinary lead-

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lined saturator is more difficult to keep up, on account of the wear and tear. I consider Mr. Cowie's plan of making his sulphate with ordinary commercial sulphur acid to be an expensive way. If he would use pyrites acid, and allow the sulphides of iron and arsenic to settle out in a separate vessel, he would find that his sulphate would be of a good colour, and be produced more economically.

Mr. DONALDSON (Lochwinnoch): I would like to know the profit made by manufacturing sulphate, compared with the price obtained by selling the liquor? I wish to ask the specific gravity of the acid. Mr. Cowie speaks of using 9 tons of acid for 8 tons 14 cwts. of sulphate, which I think is a very large proportion.

Mr. P. WATSON (Stirling): Mr. Cowie recently made a remark to me about the properties of sulphate of ammonia as compared with nitrate of soda; and I should like if he would narrate the incident to the meeting.

Mr. J. M'CRAE (Dundee): I have had considerable experience, under different conditions, in the manufacture of sulphate of ammonia. I am pleased to see the manager of a small gas-works giving his experience upon any subject; and his example should be encouraged in our Association, because it has long been felt as a drawback that only the managers of large works come forward with papers. In my experience, gas making is as important in small as in large works; the difference is only one of degree. I would say to Mr. Cowie that he is working on the right lines, and that he has obtained equally good results to those produced in larger works, where more improved appliances are used. Although he is going on in the right direction, he must not stop where he is. I think that by using pyrites acid, he could, by means of a settler, allow the sulphide of arsenic to fall to the bottom, and so the impurity which is so much objected to in pyrites acid will be easily got rid of. To use pure sulphuric acid is a decidedly extravagant plan; and this Mr. Cowie will discover in the course of his experiments. It is prescribed in the Alkali-Works Regulation (Scotland) Act that no pipe shall be connected with the waste gases produced from the manufacture of sulphate of ammonia; therefore it is necessary that the purifiers should be of such an area as to absorb all the foul gases from the production of the sulphate, and must not be connected to any chimney, but be left open. I do not agree with the remark that the consumption of acid is proportionately high, because you require 1·1 tons of sulphuric acid to 1 ton of ulphate of ammonia—just about the proportion used by Mr. Cowie. I manufacture about 400 tons of sulphate in the year, and that is my experience. Mr. Cowie is to be congratulated on

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coming forward and giving the results of his experience; and I hope other members will follow his example, and be incited to make similar experiments, and report to the Association the result of their investigations.

Mr. J. Rosie (Wick): Have any of you ever had a case of a pipe leading to the saturator becoming clogged up, and necessitating a safety-valve? I know a place where a still exploded; and the only cause which could be assigned was the pipe in the saturator choking, and thereby causing increased pressure. I observe that a good many managers work without a safety-valve; and I wish to know whether that is a safe practice?

Mr. T. D. Hall (Montrose): It seems to me that £60 is a good sum for Mr. Cowie to realize from his liquor alone, carbonizing only 800 tons of coal. I should like him to tell us what he does with his tar; and if he sells it, what he gets for it. If he produces 8 tons of sulphate from 800 tons of coal, I think that is very good.

Mr. S. Stewart (Greenock): Reference has been made to a safety-valve. I consider that any kind of safety-valve on a still is not a proper thing. What we have at Greenock is a continuation of the filling tube to within an inch or two of the bottom of the boiler; and the liquor, as pumped into the boiler, keeps the pipe clear. There is no evaporation from this sealed pipe; it is only 3 inches diameter. This does away with all risk arising from the choking up of the pipe between the still and the cracker-box.

Mr. Cowie: A gentleman asked what we were doing with our tar. We sell the tar; and I may first say, in answer to his question, that two years ago, when the Company decided to go on with this sulphate business, the whole of our residuals for the year fetched only 5½d. to 6d. per ton of coal carbonized. This year we have received something like 2s. 1d. per ton of coal. This shows the difference. With reference to a remark made by Mr. M'Crae, I may explain that unless the attendant allows the fire to get too strong, causing the gas to be thrown off too rapidly, there is no necessity to have a pipe to the purifier. I intend to increase the area of the purifier, and also to raise the condensing power and add to the number of pipes passing through cold water. We obtained from 836 tons of coal exactly 8 tons 17 cwt. of sulphate. We have no safety-valve on the pipe leading to the saturator; but we have one to the boiler. We do not experience any difficulty with the choking of the pipe to the saturator. I was speaking lately with an acquaintance of mine in Tillicoultry, who had been visiting the gas-works, and I explained to him that we obtained upwards of 8 tons of sulphate in the year. He told me of a gentleman who bought a good deal of hay from a farmer who gave his grass land

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ather a heavy dose of nitrate of soda. When a quantity of hay was carried home, the gentleman's horse refused to eat it; and he brought two men to examine the animal's mouth, believing that there must be something wrong with it. Both men declared that there was nothing wrong; and they said the defect must be in the hay. One of them obtained a sample of the hay; and, after examining it, stated that the farmer had dosed his land with too much nitrate of soda. Perhaps this hint may be taken by farmers, so that they may use more sulphate and less nitrate.

A vote of thanks was accorded to Mr. Cowie for his paper.

COAL TAR AS FUEL FOR STEAM-BOILERS.

By JOHN M'CRAE, of Dundee.

About three years ago, when the sudden and serious fall took place in the value of the secondary products produced in gas-works, many gas managers—ever desirous of doing their very best for their employers—were forced to look around for some better market in which to dispose of the products which had so seriously fallen in value. This was no easy task; and even now it forms very uphill work indeed. A comparatively new market has been created for the disposal of boiled tar at several of the German ports; but the expense and difficulty of loading ships with tar in casks take very much from the saving derived from the new manner of disposal. It occurred to me, therefore, that we must look nearer home for a remedy.

In all gas-works of any magnitude, a considerable quantity of fuel must be employed for the purpose of supplying the works with steam for the exhauster-engines, chemical apparatus, thawing purposes, &c. Whether this fuel consists of coke or of coal will not in the least affect or alter my figures. I have no doubt if any manager discovers that he is working more economically by selling the coke and using a cheap small or other coal, he will adopt the cheapest process. In Dundee, where we get a good price for coke, I found, for the purpose of steam fuel, it would be far cheaper to buy small coal costing from 5s. to 5s. 6d. per ton delivered in the works, and dispose of the coke. The question of fuel then lay between coal and tar; and I have experimented somewhat extensively to ascertain the true relative values of the two classes of fuel. For the purpose of this paper, and within the last few days, I made a further examination into the question; and the results arrived at will be those here quoted. The coal we employed was what is known as Stravenhouse small coal, which costs 5s. per ton delivered. The experiment in each case lasted 48 hours. The tar

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employed was what is known as boiled tar; the naphtha having been previously removed, but the pitch oil left in the tar. The value of this tar in Dundee is about 4s. per ton. The following are the figures:—

Coal, 10 tons 16 cwt., at 5s.	£2	14	0
Tar, 1460 gallons (or 9 tons 8 cwt., 160 gallons = 1 ton), at 4s.	1	16	7
Saving per day by using tar	£0	17	5

And this at the longest day, when we are using a mere fraction of steam, as compared with our winter requirements, and consequently the profit is proportionally less than it will be when we are in full work.

And now allow me to direct your attention for a short time to the appliance made use of in accomplishing this tar-burning. On the wall is shown a diagram giving in detail the injector known as C. and W. Walker's patent tar-sprayer burner; and it is supplied only by that firm. The tar, which has been brought forward to the boilers in a thoroughly liquid state, is discharged from the centre of the injector into the furnace of the boiler. Surrounding the centre nozzle of the injector is an annular space through which high-pressure steam passes, also into the furnace. The meaning of this steam moving along with the tar is to force a draught, as well as to raise the temperature of the tar, and so partially convert the tar into vapour; thereby making the combustion more complete. The flow of the tar is regulated by the very delicate sluices attached to the injectors. These valves consist of elongated cones and plugs, and are constructed not only for the purpose of regulating the flow of tar, but also for removing any obstruction or incrustation which may accumulate in the nozzle. In order to keep the tar in a liquid state (which in the winter time is not an easy matter), a small steam-pipe is passed through the centre of the tar-pipe; but, of course, no steam is discharged among the tar, as the presence of water in the injector prevents its correct working. The steam-pipe is simply passed through the tar-pipe, and a steam-trap attached to its end. In changing from the coal or coke fuel to the tar, little or no difficulty is experienced, and very rarely is a shovelful of any kind of solid material required. The furnace-bars have only to be kept covered to prevent the waste of tar and the too-rapid ingress of air; and when the furnaces are in full work, and being well and carefully attended to, the tar will be found to have been nearly all consumed before reaching the solid material covering the bars. The action is very much the same as in the paraffin-oil lamp. The wick is the

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medium by which the oil is brought to the point of combustion, where it is developed into light; but the wick remains little injured, although in close proximity to such intense heat. The oil burns, not the wick. In the tar-furnace, the tar itself burns, and the tar only.

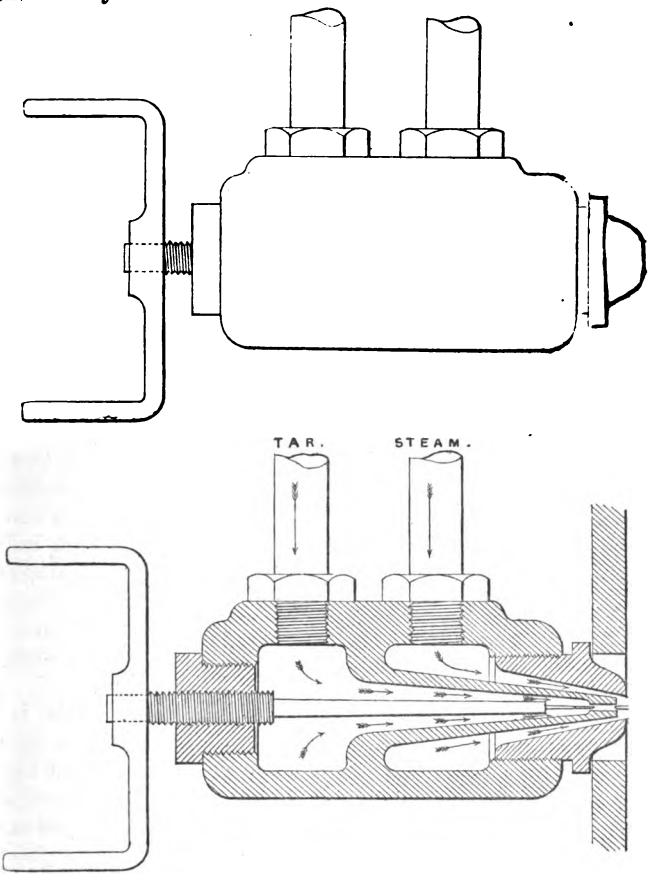

FIG. 5.—MESSRS. C. AND W. WALKER'S TAR-SPRAYER BURNER.

It will be easily understood that a little experience is necessary to enable the attendant to fully understand the quantity of tar by which complete combustion is to be obtained, and which in no case must be exceeded. The moment one atom of tar is sent into the furnace beyond that which can be thoroughly consumed, you have then the most hideous discharge of black smoke (carbon) which it

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is difficult to describe, but which can be easily understood, and, I believe, can be seen within a few miles of where we now sit. I should mention that the injectors are fitted on the furnace doors; but the connections are of such a nature that the doors can be opened without disturbing any of the permanent fittings.

And now I have told you that the results detailed in this short paper were those obtained in the Dundee Gas-Works. This is so; but were I to leave the matter here it might be inferred that I considered similar results might be obtained in any and every gas-works. I would not mislead you; and therefore must detain you for a few moments longer in order to show you how my town is different from many others. Dundee is very peculiarly situated in this respect. It is a long distance from any tar distiller's works capable of dealing with the large quantity of tar we have for sale during the winter. A large portion of the value of our tar must, therefore, go to the railway company, to cover the cost of transit between the two points, and so the tar distiller can allow us but a small figure for it at the starting-point. Then again, Dundee being far distant from the coal-fields, the coal is exceptionally high in price. I quite believe that in many of the west-country towns the coal for which we are paying 5s. per ton could be had for 3s.; and the tar for which we are receiving 4s. per ton, they would get not much under the double of this. Therefore, you see, in a place so circumstanced, the figures I have given would be most misleading. Still, I doubt not there are places as badly situated as Dundee; and it is to such places that my remarks are directed. I believe also that, in many towns distant from collieries, the tar might be sold to manufacturers for use in their steam-boilers; and such an arrangement would, I think, prove advantageous both to the seller and the user of this liquid fuel.

I think that as much has been said in regard to my subject as is necessary; but permit me to add that I believe there is a future for liquid fuels. I do not say tar, but more concentrated fuels, such as crude naphthas, paraffins, and pitch oil. When you see one of our large steamers taking coal into her bunker, it must have appeared to you that there was great waste of power here. Every ton of coal laid in must require a certain amount of power to carry it; and every ton of coal so laid in reduces the cargo-carrying power to this extent. A few gallons of oil will give you the steam-producing power of a ton of coal; and this is a fact which the owners of non-paying steamships should note. Take our locomotives also. Everything I have said in regard to steamships applies to them; and the comfort to the stokers, and the general reduction in labour would be very marked indeed. Of course, it may be

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argued that if there were such a large demand created for oils for furnaces, the old-fashioned law of supply and demand might come into play, and so force up the price of the article for which the increased demand had taken place. But I think this state of matters is rather remote, when we bear in mind the great oil-wells only now becoming developed, and the oils from which can be run in bulk direct from the wells into ships, and brought to this country at very low rates.

Discussion.

Mr. R. M. SUTHERLAND (Falkirk): I am not prepared to say very much on this subjec ; but I have been greatly interested by Mr. M'Crae's paper. The question is one of some consequence to gas managers. At the time when residual products were so low in price, the burning of tar was a question which occupied much attention. Some advocated the burning of tar, and others thought it was a pity to destroy it, seeing that it contained so many fine products. My idea is that it is very much a matter of sentiment. If there was too large a supply of tar, it did not do any harm to burn a portion of it, provided sufficient was left for the market. In London a considerable quantity was burned in one of the large gas-works; and I have no doubt that this had a good effect on the market, and that gas companies generally benefited from it. In regard to the fuel value of tar, I am not prepared to say anything very definite. A few years ago I had some experience in the burning of pitch oil when that article was difficult of sale. Our tanks were full to overflowing; and as we had to do something with it, we turned our attention to burning it. We did so very successfully, and obtained any heat required, which was under perfect control. The experiments were made at a time of the year when we were very busy; and I could not keep such correct data as to warrant me in stating its fuel value. It proved to us that when coal was scarce or dear, we could burn this tar or oil, and get whatever heat was necessary. Mr. M'Crae referred to the use of liquid fuel in a more concentrated form, especially in connection with steamers. I believe that will be done more extensively in the future, more especially if the seemingly inexhaustible supply of petroleum in Russia continues, because there they have the material in a portable and convenient form, and in any quantity, at an almost nominal price. If they manage, by the completion of some of the pipe-lines they are intending to make, to deliver this oil at a seaport at a low price, it will be used as fuel very extensively. I beg to thank Mr. M'Crae for the able manner in which he has brought this subject before the Association.

Mr. G. R. HISLOP (Paisley) : I do not rise to give any personal

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experience on the burning of tar; but it is due to Mr. M'Crae to say that some time ago I visited Dundee, and made a careful inspection of his arrangement for burning tar, and could not help expressing great satisfaction with the admirable apparatus, and the effective way in which the tar was consumed, as well as the results obtained by its combustion. Mr. M'Crae is quite correct in pointing out that what can be profitably done in Dundee may not be the same in other places, and that it will be for other managers to judge for themselves whether it would be economical to burn tar or not. As a rule, the heavy tar is always a drug on our hands; and in most cases it would be economical to burn it. In England our friends connected with The Gas Institute have advocated the desirability of burning a larger proportion of tar, in order to bring up the price of what remains to be sold. That is a matter of opinion. We are greatly obliged to Mr. M'Crae for explaining how we can get out of the difficulty, if we find the pure tar to be a drug on our hands in the ordinary outlets. I give my hearty approval of the system which Mr. M'Crae has introduced into Dundee.

Mr. A. Macpherson (Kirkcaldy): Like the previous speaker, I cannot speak from practical experience; but I have had the pleasure of seeing Mr. M'Crae's system in operation at the Dundee Gas-Works. The perfection to which Mr. M'Crae has brought his plan reflects the greatest credit on him; showing as it does that, with his usual ability, he is ready to seize on anything which, from the situation of the town, will prove of benefit and profit to the Gas Commissioners. I have no doubt that by burning his tar, which he has difficulty in disposing of profitably, he will be enabled to effect a considerable saving. Perhaps he has not had the system long enough in operation to say whether tar has a more destructive effect on the boilers than ordinary firing; and I shall be glad to have any information on this point.

Mr. W. Key (Tradeston): I wish that Mr. M'Crae had given a section showing the portion underneath the fire, in order to afford us some idea as to the quantity of air which accompanies the steam and tar into the furnace, and also whether he has any material resting on the bars through which heated air may pass up and strike the spray as it gets into the flue to help the combustion. A great deal depends on that. In one of the Glasgow works, where 300 tons of coal are consumed for steam, the engineer injects steam over the top of the fuel in the furnace; and he states that in this way he is able to obtain highly augmented steam power. I thought that if he sent the steam in underneath, he would reap more benefit. Perhaps Mr. M'Crae can show how the tar and steam

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are consumed. His arrangements I think are exceedingly simple, and must commend themselves to everyone.

Mr. M'Crae: The effect on the boiler plates of burning tar is a very proper question; and it was a neglect on my part not to mention it. We have been using the tar about a year; and the plates are unaffected. I had expected that the paper was sufficiently detailed in regard to Mr. Key's question; for I say: "In changing from the coal or coke fuel to the tar, little or no difficulty is experienced; and very rarely is a shovelful of any kind of solid material required. The furnace-bars have only to be kept covered to prevent the waste of tar and the too rapid ingress of air." That is really the state of matters. You shut down your coke fire, and turn on the tar without any alteration or rearrangement of the furnace. A little adaptation is required for the regulation of every furnace; but this does not apply to tar especially. Our coke always fetches a good price. Of course, if it was of inferior quality, it would not bring so good a price. I have to thank the members for their tender criticism; it is a repetition of the kindness I have so often experienced at your hands.

Mr. Stewart: How many gallons of tar do you use to the ton of coal?

Mr. M'Crae: Against 10 tons 16 cwt. of coal, I use 9 tons 8 cwt. of tar, or 1460 gallons.

A vote of thanks was accorded to Mr. M'Crae for his paper.

AUTOMATIC GAS LIGHTING.

By Geo. Keillor, of Nairn..

From the fact that the automatic system of gas lighting by means of an electric spark has been in practice for a few years and applied in many different ways, all with considerable success, and also from the fact that a considerable number of able papers have been read on the system at previous meetings of the Association, the subject is one which is well known, and one upon which it is difficult for me to add anything likely to be of more than passing interest.

At the outset, I wish to explain that it is not a lighter I have made, but an arrangement whereby these lighters can be used to much greater advantage than formerly. Before proceeding further I wish to emphasize the fact, in case of misunderstanding, that I have not come forward to read this short paper with the intention of making it appear that I can in the slightest degree improve these lighters so far as they are in themselves concerned. The Woodhouse and Rawson Company's Electric Lighter is a most complete instrument; and having had one in use during the whole

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of last winter, I can certify as to its unfailing accuracy in the lighting of public lamps, when fitted up in such a way as I am about to describe.

With your forbearance for a short time, I propose to describe a system of lamp lighting which I have had in practice during the past winter, whereby the pressure of gas by means of a governor combined with one of these electric lighters, operates as a complete automatic lighter; but before putting the model which you see before you in action, it may be interesting to the meeting if I were to give a short account of the circumstances under which I was led to make an experiment of the system under description, and the difficulties that I experienced in connection with the lighting of a pier-head lamp.

The pier at Nairn is about 200 yards long, and runs straight out into the Moray Firth. In 1884 the seafaring population of the town made application to the Police Commissioners for the erection of a lamp at the outer end of the pier, to serve the double purpose of helping the navigation of the Firth and lighting the entrance to the Harbour. In the following year the Commissioners, conscious of the necessity for the request, agreed to erect a lamp, and asked me for a probable estimate of the cost of extending the gas-main and furnishing and fitting-up a lamp. As requested, I submitted an estimate, at the same time informing them of the difficulties connected with carrying the gas-main along a pier, and the trouble likely to arise in lighting a lamp situated at a pier-head, owing to the sea being at times very stormy. However, I was entrusted to get the work carried out; and the lamp having been erected in October, 1885, was registered as a coast light. The light was all that could be desired; giving satisfaction to both the Commissioners and the seamen. All went well until the first storm, when, as I fully anticipated, my troubles in connection with the lighting of the lamp commenced. With the waves washing right over the structure, the lamp-lighter—I mean the animate lamp-lighter—dared not venture to the point of the pier to light the lamp; and yet it was just upon such a night as this that the lamp was most needed. To dispense with the necessity of going to the point of the pier at all, I fitted up a burner with bye-pass, so as to burn at a low point all day; but, unfortunately, the jet of gas when lowered often got blown out during gusty weather. Another objection was raised to this system in respect of the waste entailed by the burning of gas during the daytime; and hence it was that I was induced to adopt the automatic system which I am now about to describe.

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I purchased one of Woodhouse and Rawson's electric lighters with the necessary battery, &c.; and after experimenting with it at the gas-works, I contrived to combine the lighter with a governor constructed in the way shown in the model before you, which entirely obviated the necessity for laying a wire to the pier-head—a distance of about 500 yards. I need not comment on the difficulty which would be entailed by carrying a wire alongside a pier, further than to say that I was exceedingly pleased to get over the difficulty so easily. After affixing the wires to the governor in the permanent way shown in the model, I did not

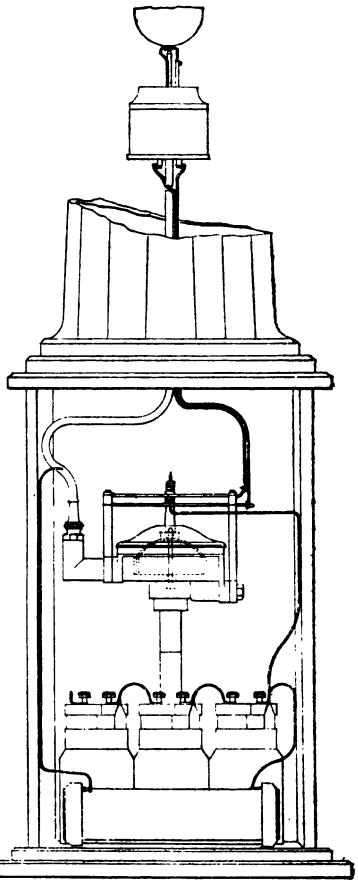

FIG. 6.—AUTOMATIC GAS LIGHTER AT THE NAIRN PIER HEAD.

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experience the slightest trouble; and as sure as the pressure at the gas-works is put on, so sure will all lamps fitted with this apparatus light up. The model, or rather the box and pillar shown is simply a rough-and-ready means of showing the apparatus combined; the battery and governor inside the box and the lighter on the top being actually the apparatus I had in use during the past winter. Now assume that I am at the present moment in the governor-house at the gas-works; the minimum or day pressure being (say) 10-10ths. The governor fitted inside the lamp-post is set at 12-10ths. Consequently it is down and the lamp out. Evening, however, comes on; and it is time to commence to load the station governor, so as to increase the pressure in the street mains for all purposes. We will accordingly now put on the first of the weights; and the moment the pressure reaches (say) 13-10ths in the street mains, all the lamps (unless the governor be loaded down to suit the time) fitted up on this system will immediately light up, as I will show by operating on the apparatus before you. Having now increased the pressure so as to raise the governor and connect the current—the lamps burning—we will suppose the pressure to be all on. Everything goes on as usual till the time for reducing the pressure; and if it is wished to extinguish any lamp (say) at 11 o'clock, or at any given hour, it is accomplished simply by loading the governor at the lamp so as to suit time and elevation. But this one being, we will suppose, a night-lamp, goes on burning till day-break; and seeing that the pressure has been reduced during the night and morning from the maximum to the minimum, the last of the weights will now be taken off; and you will observe that the moment the pressure is reduced to its minimum, the lamp will instantly go out and remain so till evening. Although the model before you only shows one lamp lighted up, I wish to explain that rows of lamps can be lit by means of one governor and battery, and that it matters not from what main the different lamps may get their supply; but there must be a lighter on each lamp, so as to convey the current, and turn the gas on and off. For a row of ten or more lamps, it is simply a matter of battery strength; and it makes no difference what the number of lamps may be, so far as the governor is concerned—it being there solely for the purpose of connecting the current.

I am confident that this is a system of gas lighting which will commend itself to all in charge of public lights. It is specially suitable for pier-head signal and night lamps as well as for town, steeple, and public building clocks—in fact, wherever gas is used. For town and steeple clocks, the system is exceedingly useful, and

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will entirely supersede the rather antiquated practice prevalent at the present time of setting the clock from time to time to turn up and down the gas according to the season of the year, and it also effects a saving of the gas burnt in these clocks during the daytime. In short, I am of opinion that there can scarcely be a more accurate system of automatic lighting than the one which I have shown. When night approaches, the pressure at the gas-works will be put on to suit the season of the year according as the day shortens or lengthens. Hence, by means of an apparatus fitted in connection with the gas supply of any public clock, building, or lamp, set to a certain pressure, the time of lighting and extinguishing would be wholly regulated by the man in charge of the station governor at the gas-works—thereby making the system completely automatic and thoroughly satisfactory.

Of course the electric lighter with battery can do all I have mentioned without the aid of a governor, if a push-button can be conveniently placed, and a wire carried to the required place, so as to perform by hand the duty which the governor does automatically; but in all cases such as I have described, and also in all outlying lamps, the governor which I have had the honour of bringing under your notice is, in my humble opinion, by far the preferable appliance. Of course, there are a great many other places where these electric lighters could be used, and where they would be exceedingly useful and economical; and it is surprising that they have not ere now come into more general use, especially where occasional lamps are required. I will briefly mention a few of the more likely places where they would be of very great service They would be particularly so at railway stations, especially in smaller towns where there is generally a considerable lapse of time between the trains; and where a light is only required for a passing train. All outside lights could be lighted instantly, by the use of these lighters, a few minutes before the arrival of the train, and put out again the moment after its departure. Facilities for fixing up the lighters at railway stations are exceptional, as the batteries are at hand, and nothing further is required but the additional lighters and wires. In hotels and large dwelling-houses also, the system would be one of the greatest public convenience. In these establishments one sleeping in the top of the house may have occasion to go to the ground floor during the night, when on coming from his room, and by pushing a button placed at a convenient point, the staircase would be immediately lighted up, and when returning to his quarters, by pushing an adjoining button, darkness would again prevail. This system of the push-button will be found to be equally serviceable in flats of spinning mills, factories, and in show and sale rooms, doctors' surgeries, &c.

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The cost of the combined automatic lighting appliance as you now see it is about £4 10s., including the cost of the governor. This governor, of course, I made to suit myself; but to light up a row of ten or more lamps which would necessitate a few extra cells to be added to the battery, and an additional lighter for each lamp, the total expense would be about 45s. per lamp. Extra cells cost 2s. 6d. each; and the best special wire about 6s. per 100 yards. The lighter and battery will last for a number of years; and all the battery requires at any time is to be replenished with a little plain water added after the sal-ammoniac, zinc, and carbon blocks.

I may here further state, for the benefit of anyone who may think of using a similar apparatus in the close vicinity of the sea, that damp from the salt water or even the sea air has a very injurious effect upon all metals and especially copper, which in a very short time gets quite green in colour, followed rapidly by verdigris; and, if not protected, corrodes the wire connections in a very short time. All wire connections should, therefore, be carefully covered up by whatever means may suggest itself. The means of protection which I adopted was to completely bury the battery in a sheet of common wadding, with a close case to cover the governor, above which I also placed a sheet of wadding.

Discussion.

The PRESIDENT: Mr. Keillor has succeeded admirably in overcoming the difficulties he had to contend against in lighting the pier-head lamp at Nairn. He mentioned that the pier is 200 yards long, and he might have stated that the lamp service is 500 feet distant from the gas main; also that the lamp is raised to a height of 30 feet. You can readily imagine the difficulty of getting along the pier during a storm, when the waves are dashing over the structure; and I think Mr. Keillor has managed very well to surmount the difficulty. Looking at the matter from a pounds, shillings, and pence point of view, I find that it takes about 13s. to keep a flash-light burning for a year which is the only other way in which automatic gas lighting can be carried out; so that it would cost five or six times as much to keep up a flash-light as it does for the interest on the first cost of adapting the electric appliance according to the plan brought before you by Mr. Keillor.

Mr. T. D. HALL (Montrose): I am sure we are all very much indebted to Mr. Keillor for the able manner in which he has brought this matter before us; and it is doubtful whether there is one here, connected with the gas profession, who does not know of some place which could be lighted by this method more efficiently than

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is being done at present, especially steeple clocks, where very often the flash-light is not used, but the lamplighter has to climb a ladder or a stair every time the gas is lighted. For harbour and beacon lights, Mr. Keillor's plan would be very useful, and very convenient.

Mr. KEILLOR: I may explain that the governor has this effect—the bell of the governor shown carries the wire from carbon of battery, so that when the pressure is put on at the gas-works, this wire is brought into contact with the top wire, which passes a current up the lamp-post to the lighter. The action of the electricity upon the lighter turns the gas on and off by means of a ratchet. The reverse takes place when we reduce the pressure. The governor falls when the pressure had been brought below 12-10ths, and connects the lower wire, turning out the gas.

The PRESIDENT: It may be pointed out that the tap (or cock) which leads to the main towards the pier can be opened and shut. If you open the tap at the entrance to the pipe leading to the lamp, you can regulate the light and put it out. A battery can be placed anywhere, so long as you carry the wire to the lamp. One battery is sufficient.

Mr. W. CHEYNE (Briton Ferry): In our place we have to light a range of lamps three miles out at sea. Mr. Keillor's plan would not suit us, because the tide rises and falls 25 feet, and you could not protect the wire.

The PRESIDENT: The battery can be placed above the highest level.

Mr. CHEYNE: Our system of automatic lighting* has worked for five years without any trouble.

The PRESIDENT: How much does it take to light the lamps?

Mr. CHEYNE: It takes 1 cubic foot of gas per hour to supply a flash-light to 12 lamps. The lamps are lighted every tide during the winter.

The PRESIDENT: But the flash-light is expensive. If the price of gas is 8s. per 1000 cubic feet, and you burn 1-10th of a cubic foot constantly for every flash-jet, it costs 2s. 8d. a year of 8760 hours; if the price is 4s., it costs 3s. 7d. a year.

Mr. A. SMITH (Aberdeen): And Mr. Cheyne's arrangement has to light the lamps every tide.

Mr. CHEYNE: The light has to be furnished for the ships coming into the port twice every 24 hours. You could not carry out a wire.

Mr. KEILLOR: The whole of this apparatus can be fitted upon the lamp-post itself; and in your case each lamp would require a

* See "Reports of Gas Associations" for 1883, p. 178.

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battery and governor, with a cheap single lighter, which would reduce the cost by 30s. per lamp; and when you send the gas to the lamp, the current and the governor connects, and the spark is ready to light the gas.

Mr. CHEYNE: But you would require to put a battery on every lamp?

Mr. KEILLOR: Yes; in your circumstances.

Mr. A. MACPHERSON (Kirkcaldy): The thanks of the Association are due to Mr. Keillor for the excellent paper he has brought under our notice. He has arranged his system very ingeniously, and apparently very effectively. In his case I do not suppose it could be better managed; but Mr. Cheyne's method is possibly the most satisfactory in his special circumstances. I have used electricity for another purpose; and it only shows that, if we take advantage of it, electricity, instead of being our great rival, can be made a very obedient servant, and of great use to us. We fill our district gas-holder about a mile from the works; and on the main through which we send the supply I fitted up a little governor with connections from a small battery. When the gas is shut off, the governor bell rises, effects contact, and rings an electric bell, and the man knows he has to look to the pressure at once, so that we have the pressure checked without going to see when the holder is filled. By taking advantage of electricity, we may save ourselves a great deal of trouble—in fact, might even use the electric light, just to show the superiority of gas over it. The thanks of the Association are due to Mr. Keillor for the lucid way in which he has described his model.

Mr. KEY (Tradeston, Glasgow): All these arrangements are very ingenious; and the author deserves credit for his ingenuity. In 1873, the late Mr. Abraham Malam read a paper to the West of Scotland Association, at their meeting in Dumfries, in which he described his arrangements for the automatic lighting of street lamps by electricity. He had a glass cylindrical jar containing an annular glass cylinder, sealed in acid, forming (with carbon and zinc) a battery. When the evening pressure was put on, the gas was admitted to the outer annular chamber; and, acting on the surface of the acid, sent up the liquor in the inner tube, thereby coming in contact with the zinc and carbon, completing the circuit, and causing the gas to be immediately lighted. When the pressure was withdrawn from the mains, the liquor in the outer cell rose, and that in the inner tube lost contact with the zinc and carbon, and the gas was extinguished.

The PRESIDENT: I am sure it will be of great advantage to us to know, should occasion require us to do similar work, that we have

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Mr. Keillor's example as a precedent to guide us in respect of automatic gas lighting.

SELLING GAS.

By Jas. M'Gilchrist, of Dumbarton.

Time was, and many present (neither grey-haired or bald-headed) remember it, when coal gas, practically speaking, had a monopoly of artificial lighting. 'Tis not so now. Oil and electricity, within a dozen short years, have made wonderful advances in public favour. The former has, in some districts taken up a considerable percentage of the business that "King Gas" so long, and if I may be permitted to add, so honourably discharged. Although I admit the fact of the steady, if slow, progress of our rivals, I do not in any way wish to assume the position of alarmist. I merely wish to point out, without prejudice (as our legal friends would say), how we have lost business, through giving too little attention to the question of selling gas. Now, had we given this question a tithe of the attention that we have bestowed on its manufacture, I am convinced that our rivals would not have enjoyed one-half of their present popularity. In the past, gas companies have not considered it part of their duty to push the sale of gas—at least, in any organized or determined manner. They were monopolists, in the strictest sense of the term; and many of them, secured by Act of Parliament, assumed that nothing could interfere with the successful business they conducted, of supplying artificial light. They, therefore, did not show that vigour in pushing business usually engendered by active competition.

No doubt they were, and still are, protected against competition on the part of rival gas companies; but there are now other "Richmonds in the field." The extensive development of oil-wells in America and Russia, and the improved means of transporting oil in bulk, have led to the markets of the world being flooded with a cheap light-giving material. The effect of bringing these cheap oils into the European market has been to reduce the value of the shale oils produced in such large quantities in Scotland. In these oils we have a formidable rival, especially among the poorer classes of the community; and whilst they are gnawing our business at the one end, the electric light is canvassing for customers at the other. The latter appeals to the owners of large business establishments as well as to the wealthier classes. At the top and bottom of the ladder, therefore, influences are at work which, if not met and checked, may seriously affect the business and revenue of gas undertakings.

But there is yet another factor that we must take into account.

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Within recent years coal gas has been applied with great success to drive engines for manufacturing purposes. The manufacturer is now beginning to use water gas as fuel, finding it cheaper than coal gas; and several firms have erected apparatus to make water gas. In the town of Leeds, where coal gas is sold at a very low price, I see from the newspapers that one firm, formerly paying nearly £3000 a year to the Corporation for gas, has laid down plant to produce water gas; so that another class of consumers is being lost. Again, the gas cooker is challenged by the paraffin stove. Well, if the ordinary housewife is slow to adapt gas for cooking purposes—owing to the smell—she will not, I think, reconcile herself in the near future to paraffin. With all these influences at work, the life of the gas manager, like that of the policemen of the lyric stage, "is not a happy one." Although it may be sad to have to admit that we cannot look upon our rivals —oil and electricity—with a distant stare of contempt, I am not going to admit that our occupation, like Othello's, is goen. It is comforting to know that the great masses of the people prefer coal gas (amid all their growling and grumbling about it) to any other form of artificial lighting. With all its faults, the people love it still; and why not? Has it not proved itself a blessing to mankind? I say it in all seriousness, as indicating a peculiar power of coal gas, that I have known of people in company who could neither speak, sing, nor enjoy themselves until the gas was lighted. With these extraordinary qualities, I say (and I say it advisedly) we are unworthy of the positions we occupy if we cannot at least hold our own against—shall I say?—nasty cheap oil or fitful expensive electricity. I could tell a long tale about the dangers of oil and the uncertainties of electricity; but I prefer at all times to push business on the merits of our own manufacture, rather than dwell on the demerits of its rivals. We all know that coal gas, when properly applied, can "give points" to all other forms of artificial lighting, and is safer and cheaper; hence my reason for not detailing its many virtues.

In the hope of exciting an interesting discussion, I now proceed to describe my ideal gas company, hereafter known, in parliamentary phraseology, as "the company." It will, in many respects, resemble the commercial house of the present day. It will canvass for business. I may say it takes more money to sell than to manufacture a sewing-machine, that sewing-machine companies generally make large profits, and that they do nine-tenths of their business through canvassers. I think, therefore, the company will find that canvassing is worth many times the small amount that it would cost. To make the canvass successful, the company

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first of all—and I would like to emphasize this point with all the strength of language I possess—must supply a gas of high illuminating power, and free from all impurities, so that a pleasant, cheerful light may be obtained. The company supplying a high quality of gas will find the consumers contented and happy (if that state can be acquired here). Even although the charge per thousand cubic feet should be a few pence higher than is charged at present, it does not, of course, follow that the light is more expensive. In towns where the illuminating power of the gas is reduced, I believe our rivals do exceedingly well. The public want light in as concentrated a form as possible; and when a few pence per thousand cubic feet can make the illuminating power all that the consumers desire, I think it is an unwise policy to cheapen the price per thousand cubic feet at the expense of the illuminating power. The public grumble more about the quality of the light than they do about the price per thousand cubic feet. It is light, not gas, the people want; and a company should be pleased to supply the quality of light that the consumers find most beneficial. The company will also look after the internal pipes and fittings of consumers, and have them arranged according to a standard of sizes for the number of lights, &c. The company will find this a great improvement on the usual system of allowing Tom, Dick, and Harry to fix the pipes and fittings according to individual fancy. Indeed, they will find this to be absolutely necessary in the interests of consumers and shareholders alike. The company will not vex its consumers by charging that irritating and obnoxious tax, meter rents. It will, like many companies of the present day, find it much better to charge the meter rent in the selling price of gas. It is an objectionable charge in the eyes of all consumers, and ought to be abolished. This tax hinders the selling of gas. The company will possess a show-room in a convenient thoroughfare, where consumers may inspect appliances for developing the largest amount of light from the quality of gas supplied, see the latest contrivances for cooking, heating, &c., by gas, and receive instruction concerning their use. It will also hire out, on reasonable terms, every form of gas apparatus that consumers may require. This will greatly assist in selling gas. The company will also develop a field, which, as at present worked, does not add materially to the gas revenue—I refer to the sale of gas to the lower or labouring classes. It will supply gas to these classes either through the medium of the automatic meter, which is, I think, a step in the right direction, or by a system of weekly or bi-weekly collections.

With the former, when light is wanted, the lowly candle, or the

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bottle of paraffin, is purchased from the neighbouring shop, and often burned in a dangerously constructed lamp. The newspapers every other morning tell pitiful tales of lives sacrificed to the "Moloch of paraffin." With this meter such danger and trouble will be avoided. A penny dropped into the box will purchase a certain quantity of gas, and the best system of doing business—namely, "ready cash"—is introduced. When the great advantages of using gas become known to these classes, automatic meters will provide an easy way of selling gas in small quantities, and a means whereby a large amount of new business may be secured. Of the other system—"weekly payments"—I am glad to be able to state that it has been tried, and been found successful. Mr. Keillor, of Nairn, adopted it about a year ago; and he informs me that out of 530 consumers, 113 are paying weekly, at rates from 3d. to 1s., according to the number of lights, &c. The system resembles, and was suggested by, the Prudential Assurance Company's method of doing business—viz., by weekly payments. Mr. Keillor argued that, if weekly payments wrought well with insurance companies, they should be equally successful with gas companies; and I am glad that Mr. Keillor, after a fair trial, can recommend the system. Not only has it procured a considerable percentage of new consumers, but many who paid quarterly avail themselves of the system, which is simply on the lines of the old Scotch saying, "Short accoonts mak' lang freens." This system may be compared to the "quality of mercy," because it "blesseth him that gives and him that takes." It is very easily wrought. The collector gets 5 per cent. of the money he collects; and for this remuneration he acts as canvasser, which he does alike in his own and the company's interest. I have ascertained from the manager of one of the largest insurance companies in the kingdom that it takes 16 per cent. to collect its money in small sums; but in his opinion 5 per cent. would pay very well for the collections under this system. In this and other cities I am confident that there are hundreds, if not thousands, of decent working people who cannot afford to pay quarterly accounts for gas, but who could easily manage to pay the amount of the quarter's gas if divided into weeks, and who would willingly avail themselves of this system, and be grateful to those who introduced it. Many families use oil, not because they consider it either cheaper or better than gas, but simply because they have so many uses for their limited incomes, that they cannot lay sufficient past to pay a three months' bill. Mr. Keillor may tell us to-day more of his system, which is calculated to assist materially in selling gas.

Messrs. W. and B. Cowan, of Edinburgh, have produced a gas-

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meter (a sample of which is on exhibition here to-day) to still further carry out the ready-cash, or rather "pay-before-delivery" system. It is a most ingenious arrangement. By it consumers can purchase from 100 to 5000 cubic feet of gas, just as they could buy as many pounds of cheese in a ready-money grocer's shop. Time will test whether the public will think fit to pay for gas before they get it; but the meter, I have no doubt, will do its duty faithfully and well. The intention is that a gas company may be able to sell a quantity of gas to a consumer, and when such quantity has been used, the meter will stop and shut off the supply. The long moveable and stationary pointers are set by a key at the quantity sold—say, 2000 cubic feet. The moveable pointer then begins to travel back to zero, at which point it stops. By means of the stationary pointer, any dispute regarding the starting point is prevented; and, further, consumers may see at any time how much gas has been used, and the quantity still to be consumed. The meter moves the ordinary index, into which is geared the wheel of the moveable pointer; and while the latter is being actuated by a key, it ungears with the index train. The result is that the ordinary index always keeps a record, and thus checks the quantities indicated from time to time by the moveable pointer.

The gas companies of the near future will also protest against the iniquitous system of valuation adopted by assessors when valuing gas-works. They will fight until the coal-gas industry is valued upon the same basis as other industries, and get rid of the greater part of this unjust tax that militates against selling gas. The company will also adopt the co-operative system, that has been so successful throughout the country—viz., that of making all the consumers shareholders (who are not included in the automatic or weekly-payment system), by charging deposits at, say, the following rates:—5s. for a house of one apartment, 7s. 6d. for a house of two apartments, 10s. for a house of three apartments, 15s. for a house of four apartments; larger houses at corresponding rates. The amount for shops and other places of business to cover four months' consumption in winter. From experience, I can assure you that you save much time and trouble in collecting accounts. No bad debts are made. Indeed, it is rather odd, a profit is sometimes made out of bad debts, through consumers running off and leaving deposits amounting to more than their accounts. This enables the manufacturer to sell gas at the lowest price, and when consumers get 5 per cent. on the amount of their deposits, they have "nothing in the world to grumble at." Gas companies who charge deposits as they think

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necessary, generally create a bad feeling among the consumers. Ratepayers, as regards deposits, should all be put on the same level. The man in good position at least should not object to pay a deposit, because by this system he does not require to pay his portion of the debts of runaway consumers in towns where deposits are not demanded.

In conclusion, the gas corporation of the future will not take gas profits to pay rates that, in justice, ought to be paid by the ratepayers generally. Public opinion is ripening on this vexed question; and the day is not far distant when this iniquitous tax will also be abolished, and gas sold at as near cost-price as possible. Mr. Chairman and gentlemen, I have done. My ideal gas company—or gas corporation if you will—is not to be found in this enterprising country. Can you give me any reason why gas undertakings should not push for business like other commercial firms?

Discussion.

The PRESIDENT: You have heard a very interesting paper, prepared and read in his own inimitable way by Mr. M'Gilchrist; and we shall now be pleased to hear any remarks.

Mr. BELL: Does the money turn the spindle of the index of the prepayment meter?

Mr. M'GILCHRIST: This is to meet a case of contracting with the gas company. If a customer wishes to purchase say 1000 feet of gas on the proposed principle, the gas inspector turns on the gas. When the quantity paid for has been consumed, the gas is automatically turned off.

Mr. KEY: From the title of this paper, I expected something very humorous and very racy; and I have not been disappointed. No one but Mr. M'Gilchrist could have put his paper in such pleasing phraseology. I think his plan of engaging canvassers, or those who receive a percentage for the collection of money, for the purpose of canvassing for gas consumption, is a very good one. He might have gone a little further, and suggested the wheelbarrow man; for, in the early days of the Edinburgh Gas Company, bags made of leather or other material were filled with gas, and hawked about the streets in a two-wheeled barrow, and sold to one person here and another there for one or two nights' supply. The customers could then see the volume of gas they were receiving. Meters are a great mystery to many people.

Mr. S. STEWART (Greenock): I agree with Mr. M'Gilchrist that there should be small payments, as there would be much more gas consumed if we had them. I do not think it is right to take large deposits. By doing so you prevent many people from burning

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gas. I know that many people in Greenock do not use gas because they cannot pay the deposit. I do not think we should press people too hard. Of course, a great deal of caution should be exercised; but I cannot understand why gas companies should expect to carry on their business without risk. Ordinary traders do not ask their customers to make deposits; and I do not see the force of gas companies doing it. There is a very strong feeling against meter-rents; and, in my opinion, meters should be supplied free. I agree with Mr. Key that Mr. M'Gilchrist has given us a very able paper.

Mr. G. R. Hislop (Paisley): I cannot agree with Mr. M'Gilchrist in the matter of supplying meters free; but I maintain that it would be right to charge for them only the annual cost of maintenance. That is as far as anyone can be expected to go in this direction. No doubt the "power of littles" may be made manifest by encouraging the use of gas amongst small consumers. In Paisley we are very lenient in regard to deposits. We exact them from all parties with whom we are not acquainted; but, as a rule, the deposit is returned on the first account being paid. Suppose we take a deposit of 4s., and the consumer burns 4s. or 5s. worth of gas, the amount is deducted at the end of the first quarter; and I think the justification of this course will be manifest when I tell you that our loss from bad debts is only ¾ per cent. on the gross revenue. Though the deposit is exacted, the system we go on does not involve any hardship. We "square accounts" generally at the end of the first quarter; but if we are not very sure about the parties, we continue the deposit until the second quarter. It is all settled up, however, before the end of the year.

Mr. A. MacPherson (Kirkcaldy): Like the other speakers, I have to congratulate Mr. M'Gilchrist on the able manner in which he has brought this subject before us, and on the admirable way in which he has treated it. I see no objection to canvassing for consumers. Although it may be a little expensive, it would pay in the end. There cannot be any danger in canvassing on the prepayment system, for we should be sure of our money. Many people would gladly burn gas who do not now use it for the simple reason that they cannot pay the quarterly accounts; but if we had monthly accounts, small consumers would make an effort to pay. They could go to the office and pay for a quantity of gas as often as they pleased; and it would be their duty to watch and see when the gas was about to run out. I cannot agree with the suggestion to do away with meter-rents. I do not think the abolition of these rents is fair. Suppose we put a three-light meter into the house of a consumer who burns (say) 5000 cubic feet of gas per annum)

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and a similar meter into the house of one who burns 10,000 cubic feet, there is the same amount of capital expended n measuring the 5000 as in measuring the 10,000 cubic feet; and it goes on in increasing ratio for the larger consumer. I think a small deposit is very beneficial until we know the customers with whom we are dealing. If a stranger comes to us for a supply of gas, we ask if he has burnt gas before; and unless he can produce a clear bill for his last payment, we exact a deposit of 5s. until he makes two payments, after which the deposit is cleared off by the next bill. There is one thing, I think, which we ought to impress on the people, and that is that we should have the control of the gas up to the point of combustion. My experience within the last few years has been that speculative builders run up houses to sell; and the gas-pipes are simply thrown in. There is no regard to size or anything else; and the tenants are not a couple of months in possession before a complaint is made that they cannot get gas in some part of the house, and that the lights are jumping. Until gas companies make a determined stand, and say they will not supply gas until they are satisfied that the fittings are of proper size and properly laid, there will be no remedy. If we combine to have the control of the supply, or at least to see that the fittings are properly put into houses, our duties will be simplified, and a great deal of extra pleasure and certainly additional light will be given to consumers of gas in general. If ever such an ideal company as Mr. M'Gilchrist has sketched is formed, we shall all know where to get a most efficient and humorous manager—viz., in Mr M'Gilchrist himself.

Mr. J. Donaldson (Lochwinnoch): Mr. M'Gilchrist does not mention any discount allowed to consumers who pay their accounts within a certain period. I think this is a good plan, and has worked well in several places.

Mr. A. Smith (Aberdeen): There is a large amount of useful information in Mr. M'Gilchrist's paper. It would be a great matter if we could get short payments, the want of which keeps many consumers back. In regard to the supervision of pipes laid in buildings, I may mention that in Aberdeen building is going on rapidly, and that there is no supervision. We have no charge of the pipes, as our duties, according to our Act, cease at the meter. The result is that in many cases the pipes are simply thrown into the houses; and the waste and loss to the consumers are very great. The defects are so serious that wet meters have become of no use, and dry meters have to be introduced. I think the gas-supplying authorities should have the supervision of fittings in houses.

Mr. G. Keillor (Nairn): In June, 1887, I brought the subject

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of weekly collection before my Directors. They thought it would be a complicated and troublesome system ; but after I explained the system thoroughly, they saw there would be no risk, and that it would be simply a matter of time to work it out. We have a collection-book specially made up with double money columns. When a consumer commences on the weekly system, we also begin to collect. We enter the quantity of gas consumed at the end of three months, and then total up the collection. If there is any balance, it is shown on either side. When I first started this system, an insurance agent told me he was quite certain it would not be more troublesome to collect gas-rents weekly than it was to collect insurance premiums. We have 530 consumers, of whom 113 are on the weekly system. Of this 113, 57 are new consumers. The money collected from these 113 consumers last year was £109. The collector—a young lad—calls twice a week, on Thursday and Saturday, and we pay him 5 per cent. on the amount brought in. He does the whole of the work in three or four hours each week, and also canvasses for new consumers, so that 57 new consumers in one year is rather good. Our selling price for gas is 7s. 6d. per 1000 cubic feet, less 10 per cent. discount for cash ; but no discount is allowed to those who pay weekly. Gas for cooking and heating purposes is sold at 4s. 7d. per 1000 cubic feet ; the supply being by special meter, and, as a rule, by a separate service-pipe. It is now three years since we reduced the price for cooking and heating to 4s. 7d. ; and we have 55 cooking and heating stoves in use. It will pay us to still further reduce the price for a day consumer.

Mr. Hislop : Does the consumer pay for the hire of the meter ?

Mr. Keillor : Yes, for lighting purposes ; but not for cooking.

Mr. M'Gilchrist, in reply, said that he thought the subject of weekly payments and consumers' internal pipes and fittings should be taken up by the Committee, who should prepare and present a report to the Association. Something should really be done to draw in more consumers from the class to which he had referred. Twelve years ago he persuaded the Corporation of Dumbarton to adopt a standard of sizes for internal pipes for the supply of houses ; and from that period no pipes had been introduced in new buildings in Dumbarton without being inspected by a representative of the Gas Corporation. If they were, upon inspection, found not to be in accordance with the standard of sizes issued by the Corporation, they were turned out, and replaced by pipes of proper dimensions. The general public were grateful for this action of the Corporation. Upon the matter of discounts for early payments, he argued that, when gas consumers had three months' credit, they should not be allowed more than a month after-

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wards to pay their accounts. Referring next to the question of meter-rents, he said he was sorry that Mr. MacPherson had not been educated up to the point of supplying meters free; but this was his misfortune rather than his fault. Replying to the argument about the unfairness to the large consumer of not charging meter-rents, Mr. M'Gilchrist said the same argument would apply to a railway company, which would, on the same lines, be entitled to charge more for a 20-stone traveller than a 10-stone traveller. In every business difficulties such as these had to be encountered; and they must be overcome. Customers must be treated not altogether on their individual merits, but according to a broad, general principle, which should apply to every class of consumers, and at the same time tend to forward the interests of companies supplying gas. Mr. Hislop had always been antagonistic to free meters; but he (the speaker) trusted that Mr. Hislop would live to see the error of his way. It would, in his view, tend to the advantage of gas corporations if the charge for the meter was included in the price of gas. When the meter-rent prevented people from consuming gas, the manufacturer should, in his own interest, give way. Consumers of gas should be treated in much the same way as traders treated customers. If complaints should be made, rather than make a fuss about the matter, say: "We will allow it." Gas companies should have a little more of the spirit of give and take about them, and should not stick to the hard-and-fast lines of the past. With regard to deposits, Mr. M'Gilchrist contended that if it was left to the option of gas managers to charge or not to charge deposits, it placed them in an awkward position. Supposing a man were to pay his gas account for two years in succession, it did not follow that he was an honest man. The third year he might run up a bill and not be able to pay, or disappear; and the loss had ultimately to be borne by the consumers who paid their accounts regularly. When a man of dishonest habits got into debt, he sometimes felt inclined to go off to another town rather than pay up his arrears. Therefore, he (the speaker), thought that the deposit system was a check which acted in favour of the company or the corporation, and did no harm to consumers because they got more interest on their deposits than they could get in other securities. He had known cases in Dumbarton where the consumer wanted to increase his deposit because it was a good investment. Mr. Hislop, in speaking of the system adopted in Paisley, said it was an argument in its favour that the bad debts amounted only to ¾ per cent. on the revenue. Looking to the gas revenue of Paisley, this must amount to a considerable sum per annum. Were Mr. Hislop to

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adopt the Dumbarton system, this ¾ per cent. of bad debts would appear on the other side of the account. Again, gas companies were not like ordinary commercial firms in the matter of customers. The ordinary trader could select his customers, and sell only to such as he approved of; whereas an incorporated gas company must supply gas to every ratepayer who applied for it, irrespective of his financial standing. Mr. M'Gilchrist concluded by saying he was glad that the subject which the President had selected for him had been so well received by the gentlemen present.

REGENERATIVE FURNACES FOR SMALL GAS-WORKS.

By JOHN SMITH, of Rosewell.

As most of the gentlemen here are now pretty well acquainted with the principles of the regenerative furnace, I do not intend in the following paper to say anything of a general nature with regard to it, but to confine myself principally to what I have done, how I have done it, and the results thereof.

In the month of July last, I constructed a regenerative furnace at the Rosewell Gas-Works, which is still at work, and is giving full satisfaction. The furnace in question is adapted to a setting of three retorts; and as is generally the case, the first operation was to excavate under the oven and in the floor to the depth of 3½ feet, and to underbuild the side walls of the oven. The bottom of this excavation having been laid with 3-inch pavement brick bedded in lime, the foundation of the flues and producer was commenced. The latter is placed inside the oven under the front of the retorts, and is 2 feet square inside, and 3½ feet deep. The flues—four in number, and 9 in. by 9 in. square—occupy the rest of the space, and extend 3 feet outside the back of the oven, where they are carried to the chimney by a cross flue. These flues were covered with 3-inch checked covers; and another set of flues commenced on the top of them, and covered up in the same manner. A third set of flues was built, and covered up the same way; this last covering forming the bed of the oven. The top and bottom sets of flues are for the waste heat passing from the oven to the chimney; and the middle set is for the heated air. The producer being built with these is now 3½ feet deep; a hole 15 in. by 15 in. being left at the bottom for cleaning it out. The air for the hot-air flues is admitted at the back of the regenerator, and is carried forward by two 4-inch fire-clay pipes to nearly the front end of the two centre air-flues. It goes back outside these pipes, but still in the two centre flues, and returns to the front in the two outside air-flues,

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entering the top of the producer by three ports at each side. The two fire-clay pipes are used for the purpose of carrying the air to the starting point; there being no other means of admitting the air to the front end of the two centre flues. The gases rising from the producer go into combustion with the heated air, and pass up the front portion of the retorts, over a middle wall, down the back portion, then enter the upper set of flues, travel forward, descend to the lower set of flues, and flow outward (as before stated) to the cross flue that leads to the chimney. The upper door of the producer consists of an iron frame 11 inches square inside, and bolted to two brick cheeks; the whole fitting into the angle formed where the front wall and floor meet. A brick to fit this door, bolted to a piece of sheet iron, serves as a cover, and can be lifted off and on when required.

The producer is filled by applying a scoop to the mouth of the retort when drawing, and is cleaned out from below every 24 hours; an excavation having been made in the floor for that purpose, which is covered over with a piece of sheet iron 6 feet long 3 feet wide, $\frac{1}{8}$ inch thick, and on the inside of which three pieces of angle iron are rivetted across to give it strength. The primary air is admitted at the door at which the producer is cleaned out. There being no fire-bars and no side holes for the admission of air, a piece of 4-inch cast-iron pipe, about 2 feet long, is laid down with one end sticking out at the door, the other reaching nearly to the back of the producer, and carrying a portion of the air to that point. This pipe also serves another useful purpose. Having no steam to keep the bottom of the producer cool, I use water for that purpose; and by allowing it to enter the pipe at something between a drop and a run, it is by the heat immediately converted into steam, and answers the purpose admirably. The distance the heated air has to travel is about 21 feet; but, the flues being large for the small quantity of air required, it travels very slowly, and before reaching the producer is nearly as hot as the inside of the oven. The size of the flues for the waste heat—four in number and each 9 in. by 9 in. square—may seem to be large for the size of the oven; and I have no doubt they would do if they were smaller. This, however, was the size which was most convenient for me, and I thought it best to err on the safe side; for if at any point the flues are contracted, intense heat, choking up, and destruction to the brickwork is generally the result. In the construction of this furnace, I have taken a slight departure from any I have seen or heard of—that is, in making the horizontal part of the building the conducting partition, or the partition between the waste heat and the heated air. My reasons for doing so are these: The

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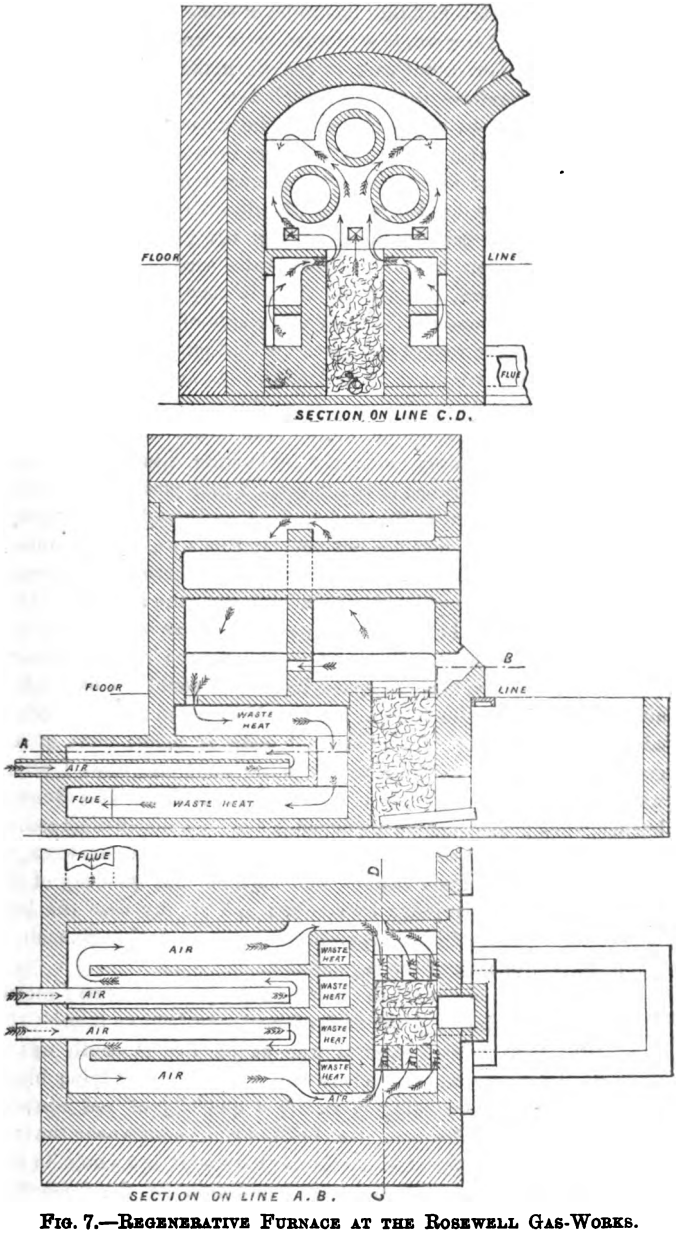

FIG. 7.—REGENERATIVE FURNACE AT THE ROSEWELL GAS-WORKS.

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vertical portion of the building has to be of some strength, because it is upon this that the whole structure rests; and, there being no stress upon the horizontal part, it can be made an inch or two thinner, and therefore there is much less of that good non-conductor—brick—between the two. The horizontal part, which consists of covers, also makes the isolation between the flues more complete. Another departure from the usual method is in filling the whole space under the oven with flues, and not leaving a vacant space as is usually done. When the producer is placed inside a small oven, it and the side walls occupy nearly 4 feet. The space, therefore, left for the flues is very limited. In this furnace I have dispensed with flues at the side of the producer, but have used up all the rest of the space for that purpose.

This furnace was lighted up in August last; and is still in operation, giving general satisfaction. Some things about it seem to me rather strange. For instance, I have read about it being possible to regulate the secondary air supply by looking into the oven and judging by the appearance of the flame. I had pictured to myself the gas rising black from the fuel, and going into flame—Bunsen burner like—when it met the hot air. In this I was disappointed. It is true that when the charge is newly drawn, there is some flame, and you can see the combustion taking place at the air ports; but, generally speaking, there is no flame at all to be seen. Still the heat kept increasing, until it had to be checked by the damper. What then could be keeping up the heat? It could not be the hot air passing through the fuel, as in the old fireplace; for the air is admitted on the top of the fuel. I have no doubt most of the gentlemen here know what was puzzling me; and what I afterwards found out for myself—viz., that the blue flame of a Bunsen burner, when placed inside a fire or red-hot oven, entirely disappears; and although still there, does its work invisibly. As far, then, as my experience goes, you cannot well regulate the quantity of air by sight, but must judge by results; and in my case the best results were obtained by an opening of 2 square inches in each of the pipes at the back of the regenerator.

At first I cleaned out all the ashes in the producer every morning. By doing this, a good deal of heat was lost, as it took the fire about two hours before it was at its full strength again. Latterly, I found it better to clean out only what was lying black at the bottom; there being generally a quantity of red clinkers sticking upon the sides, and often bridges right across near the top. A few strokes from the steel bar from above sent the whole to the bottom, and formed a much better foundation for the fresh fuel than the clean bottom of the producer. If fire-bars are used, this

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might be different. The clinkers are sometimes rather hard to remove if the water is neglected, when the heat is very high. A small quantity of spent shale, however, drawn from the retorts along with the coke, was found to be an excellent thing for preventing clinkers being formed. The fire is damped down at night for about seven hours, during which time there is some loss of heat, but nothing like what would be with the old fires. At the point where the waste heat first enters the flues, there is an accumulation of dust 3 inches deep; otherwise the flues are as clean as at the commencement. I attribute this deposit to the fact that I use dross to some extent for firing. The brickwork does not appear to be affected in the slightest; although the heat was sometimes so intense that I was afraid to look into it, and as far as I can judge from it at present would last for a number of years.

And now, as to the important question of economy. Would the saving effected compensate for the first outlay? In my case the saving is very great; but there are special circumstances to take into account. In the first place, the gas-works under my charge are close to the Whitehall Fire-Clay Works, where the best of material can be had at a moderate rate—the cost of carriage being almost *nil*. The whole cost of this furnace amounted to only £8. In the next place, I use shale to a large extent for making gas, from which there is no coke; and I have therefore to use a large quantity of dross. Formerly I required to have two ovens going for five months of the year; whereas, with the improved heat working off the charge in three hours when it used to take four hours, I can now do with one oven going. The result of the whole is that, whereas formerly I used 18 tons of dross per month, I now only use 3 tons; the coke from one of the retorts, which is charged with splint, being nearly sufficient to keep up the heat. But, as I said before, this is partly due to special circumstances; and the saving is not so much in the summer time. There is also some saving of labour, as the fire requires less attention.

In this furnace, although I had what appeared to me to be feasible reasons for departing from the usual mode of construction, I do not claim to have constructed a better furnace than anyone else. It does its work well, and gives no trouble whatever; but that may only go to show how the same end may be accomplished in many different ways. Had I been less favourably situated, I might not have been justified in going the length I have done. More especially was I convinced of this when seeing Mr. Turnbull's furnace at Lauder in April last. It does its work beautifully; is simplicity in itself; and would not cost half of what mine would.

The question therefore seems to be, What length should we go?

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whether should we attempt to recover the whole of the waste heat, or be contented with taking the best of it? I think I have gone quite far enough; and in another furnace which I am at present constructing I have not gone so far; but having a large choice of materials ready at hand, and full liberty from my employer to use my own discretion in the matter, I was placed in a more favourable position for trying the experiment than most of those in charge of small gas-works.

In the furnace which I am at present building, the producer is exactly the same as in the first one, but the flues are different. The waste-heat flues are three in number. The two outside ones are 18 inches deep and 9 inches wide, and the middle one is 18 inches deep and 12 inches wide. The heat after passing over the retorts descends at the back of the oven into the two outside flues, comes forward to the back of the producer, and returns to the chimney in the centre flue. Each of the two partitions between the centre and outside flues consists of two 3-inch brick walls 6 inches apart, and tied together with baffle bricks forming something like a hollow brick wall. These hollows are used as hot-air flues. The air is admitted at the front, and passes along the side of the producer and along the bottom of the two outside flues in a 5-inch fire-clay pipe. When at the back end of these flues, it is turned into the hollow walls, travels forward, and ascends into the bed of the oven, where it is conducted into each side of the producer by a channel 6 inches broad and 3 inches deep. The result of my year's experience has led me to modify the system thus far. I do not expect any better results from this than from my first one, but it is much less complicated, and will cost only about one-half. Such a furnace as this would be of considerable advantage in any small, more than in medium-sized gas-works where a regular night shift is kept on.

Discussion.

The PRESIDENT: I hope you will enter heartily into the discussion of this subject, which is a most interesting one, and one which is intimately connected with the success or otherwise of a gas company. I trust that those who have a direct interest in, or who intend to adopt a similar furnace, will take part in the discussion.

Mr. ALEX. SMITH (Aberdeen): There is no question that this gentleman deserves great praise, for he has accomplished a smart piece of work. There is one point to which I wish to direct attention, and that is the position of the producer. It appears to me that he would have some difficulty in taking the clinker off the sides, on account of being so far under the setting. We are

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told that the cleaning out is done only once in 24 hours. I should have thought it would have had to be done more frequently—perhaps once every six hours. There is no doubt this is a step in the right direction. All the papers brought before us to-day have contained much useful information; but it is impossible for anyone to stand up on the impulse of the moment and give a full criticism. If we had the papers in our possession two or three days beforehand, we should be able to enter much more fully and intelligently into their discussion; and I trust this hint will receive consideration.

Mr. S. STEWART (Greenock): I have to congratulate our friend on his very ingenious arrangement. I approve of the system of having the producer inside. In the Klönne bench we take out the clinker once in every 48 hours; the time depending on the fuel used. If we are careful to choose a fuel containing a small percentage of ash, the clinkering may not be required for a considerable time. Mr. Smith's arrangement is useful, because it allows the use in small gas-works having only a few retorts in one oven; and, what is much more important, it enables them to keep the retorts in heat during the night.

Mr. D. YOUNG (Dalkeith): I have visited the Rosewell Gas-Works, and seen this furnace in operation. I went there on a Monday forenoon, when the furnace had not been cleaned out for 60 hours; and in the retort-oven there was a good working heat. I have put in a setting on this principle; and if it produces the same heat, working spent shale and a not very good splint coal, I shall be well satisfied.

Mr. W. KEY (Tradeston, Glasgow): Mr. Smith deserves great credit for this setting. He has taken a decided step in advance; and those who alter their settings to save labour and wages and fuel do great good to the gas profession. This is a simple arrangement; and it speaks volumes for Mr. Smith's ability that he has to draw his clinker only once in 24 hours, while keeping up a good heat.

The PRESIDENT: I gladly join the members who have spoken in thanking Mr. Smith for bringing this subject before us in such an interesting way. No doubt it has cost him much thought and trouble; but he will gain advantages in many respects from the use of this furnace. Perhaps at a future meeting Mr. Smith will favour us with the fuller results of the working of the furnace.

Mr. SMITH: Mr. D. Young has kindly answered one of the questions in regard to the length of time which elapses between the cleaning of the fires. We generally clean the fire every day except Sunday. The clinkering at first caused us some difficulty; but since we

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began to use spent shale, clinkering, in the sense of clinkering, has not had to be resorted to for three months. If we just touch the clinkers, they loosen without difficulty, and the stuff falls away.

The PRESIDENT: You speak of not clinkering on Sundays. Do you work the retorts on Sundays?

Mr. SMITH: There is not much difference in the quantity of fuel used on Sundays as compared with other days.

Mr. KEY: Will Mr. Smith inform us how he gets the clinker off his furnace-bars, where the primary air comes into contact with the fuel?

Mr. SMITH: We never try to take the clinkers off there. There is a quantity of black ash at the bottom; but no heat to cause clinkers. Whatever clinkers there may be are on the top, where we can easily get at them.

THE SCRUBBING, CONDENSING, AND WASHING OF COAL GAS.

By WILLIAM KEY, of Tradeston, Glasgow.

In considering these subjects, I shall do so in the order given in the title to this paper, though not for any fanciful or accidental reason; for as I proceed it will become apparent to you why they are so placed. I shall also deal with the arrangement from a consideration of the mechanical effects produced on the gas, and will not enter into any question in the meantime of any improved results or otherwise in the secondary products either by tar or ammoniacal liquor, from the fact that there has been no opportunity of forming an opinion thereon.

Scrubbing.—The scrubbing and washing of coal gas have of late years become almost synonymous terms; for in both vessels water is the chief agent employed, and motive power is also brought into requisition for both sets of apparatus, not only to rotate the apparatus, but also to supply means to distribute the water, and work up the resultant ammoniacal liquor, by repumping, &c., to the desired strength of the contained ammonia. I shall, however, make a thorough distinction between these apparatus by designating the scrubber an apparatus for the extraction of the heavy condensable vapours; and no water will be used in connection with the arrangement I shall describe for the purpose. No. 1 [see p. 208] is designed for the extraction of the tarry and watery vapours from the gas, while it is still hot. The gas flows direct to the scrubber on its leaving the hydraulic main. The passing of crude gas in pipes, along with the tar that may be condensed from it in its travel, for considerable distances is most objectionable, and should

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be carefully avoided. The temperature of the gas must not be allowed to fall under 120° Fahr., and is preferably conducted to the scrubber as hot as possible.

This scrubber is designed of a capacity to thoroughly deal with 60,000 cubic feet of gas per hour; and is 5 ft. 3 in. inside diameter, by about 21 feet in height over all. The gas travels upwards for 15 feet of this height, which is the distance between the inlet and the outlet pipes. Similar vessels may be placed in a horizontal position, and the one over the other, to effect the same purpose. The outer case of the scrubber is of wrought iron, and is lined the entire length with corrugated sheet iron. A shaft passes through stuffing-boxes in the bottom and crown, to which is attached a grooved pulley, to be driven by a rope from another of a larger diameter fixed on a main shaft, and driven by an engine; so that by frictional, or other gearing, one or more of the scrubbers may be set in motion as the increased manufacture of gas may demand Keyed on to the scrubber shaft are several cast-iron arms, to which are attached fans, butterfly-wings, or "wipers," made of corrugated or ribbed sheet iron as shown; or several layers of wire cloth of various meshes may be used. These are caused to rotate at a speed of about 300 revolutions per minute; whereby the gas is repeatedly forced to pass through the narrowed and irregular passage between the corrugated iron lining of the outer case and the ribbed wipers. Thereby the gas is impinged upon by the revolving surfaces; and otherwise is made to impinge upon the corrugations of the scrubber case. Thus the whole of the tarry and watery vapours are extracted. In a vessel of this size, the flow of gas, at the rate of 60,000 cubic feet per hour, is sufficient to refill it three times in a minute; so that the wipers, revolving at 300 revolutions per minute, enable the gas in its passage through the vessel to receive 100 wipes or switches from the wipers before it passes off at the outlet completely scrubbed and clarified. I have here a model of this scrubber, made somewhat after the design shown by No. 4. The internal diameter between the corrugations of the case is 5 inches; and the height of the travel of the gas is 14 inches between the inlet and outlet.

I passed about 50 cubic feet per hour of crude gas through the scrubber, at a temperature of 120° Fahr., while it was stationary. These papers I now show you were exposed at a distance of (say) 0·1 inch from the outlet for 15 seconds by a stop watch; and they received the impression shown, from the tar in the crude gas impinging on the surfaces. Thereafter the model was set in motion; and the other side of the papers were exposed for a similar time, with a result as shown. The whole of the tarry and watery

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vapours had been eliminated; and the surface of the paper impinged upon remained quite clean. Having attached a meter to the outlet, both while the scrubber was stationary and in motion, it was found that there was no retarding effect to the flow of the gas during the latter as compared with the former experiments. The same volume of gas was registered each time; thus indicating that the apparatus caused no back pressure—in fact, the water-line of the pressure-gauge remained steady under both conditions. The crude gas by this new process, having been thoroughly scrubbed and clarified, is now in a proper condition to be passed on to the coolers, generally termed the condensers.

Condensing.—Of all the apparatus used in the purification of coal gas, the designs for condensers are of the most heterogeneous description; and in some gas-works, as more surface was required for this purpose, a different form has been brought into use each time, so that sometimes the gas is partly condensed by passing through the various sections in a combination with several of the following types of condensers:—An enlarged hydraulic main; a pipe fixed round the inside of the retort-house; a pipe carried round the outside of the retort-house; an old boiler; a rectangular cast-iron box; a disused gasholder; a gasholder tank; pipe condensers by far too small; pipe condensers by far too large; horizontal pipe condensers; vertical pipe condensers; spiral pipe condensers; portions of annular condensers; portions of battery condensers, &c. It is impossible to discover the particular recommendation that accompanied each section, and decided the position of each design along the line of cooling operations.

For many years past I have experienced much difficulty in speaking in the presence of gas manufacturers of the temperature to be maintained in the cooling process; in fact, I have been frequently assured that the temperature has not in any way to be considered in the purification of coal gas, and if the condensers possessed the quality of being able to lower the temperature of the gas to that of the atmosphere, then they were considered to be efficient in every respect. Bearing on this subject, I will read to you the letter which appeared in the "Correspondence" columns in the issue of the *Journal of Gas Lighting* dated Oct. 4, 1881.

Of all condensers, I consider that the form most destructive to the gas in its application is the pipe condenser carried in long straight lines, of a spiral form, with the pipes laid to a slight continuous fall, so that the gas might travel in contact with the tar. Then perhaps the vertical pipe condenser is the next most destructive; and along with this form, I would class the annular condenser—condensers so formed that when the temperature has

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fallen under 100° Fahr., the gas is passed slowly through a vessel of considerable area, and then through a small pipe, with consequently a very much increased velocity, to again enter a large vessel or chamber. This process, when repeated several times, must be very destructive to the illuminating power of the gas, and especially so as the temperature lowers, owing to the scrubbing process in these small pipes by the contact of the gas and the velocity of the impact with the cold and tarry surfaces—similar to what is frequently observable in towns where a rich gas is manufactured. The main-pipe, which is too small to permit of the district being supplied under a low pressure, and a slow delivery, has to be put under a higher pressure. The gas passing through it at a great velocity, hydrocarbon vapours are deposited; and the rich gas, by frictional contact with such a surface at a low temperature, is deprived of its light-giving hydrocarbon vapours, and is found to be of a much lower illuminating power further on than when it was sent from the gasholders.

The gas as it passes from the hydraulic main does so in the familiar condition of being accompanied, while it is still hot, by a dense brown vapour, resembling smoke; the visible matter being hydrocarbon—tarry and aqueous vapours held in suspense. Any form of condenser to which the gas in this state is led which necessitates it flowing through long straight lengths of pipe at considerable velocity, only serves as a means of carrying forward as far through the apparatus as possible these tarry vapours, because of the quick travel along unbroken lengths of pipe, and owing to the affinity tarry matter has at low temperature for the hydrocarbon vapours in the gas, the gas is lowered in illuminating value by several candles in passing through the last portion of such condensers where the temperature is low.

Some of the reasons why the annular form of condenser is one of the worst to employ as a cooler of coal gas are: (1) Because, the gas passing up or down the narrow annular space with a considerable velocity in a straight line, the tarry vapours are carried forward uninterruptedly. (2) The air space, being surrounded by the annular chamber containing hot gas, the air in its passage upwards becomes heated, so that the upper portions of the condenser tubes thereby lose much of their cooling power. (3) Owing to each individual annular tube being entirely separated from its neighbour, the changes of temperature brought about by hot rays of the sun, sudden showers of rain, by heat by day, and by cold by night. (4) Their singular form preventing thorough control over the temperature of the gas in severe frosty weather.

I have not prepared a diagram to show you what, in my opinion,

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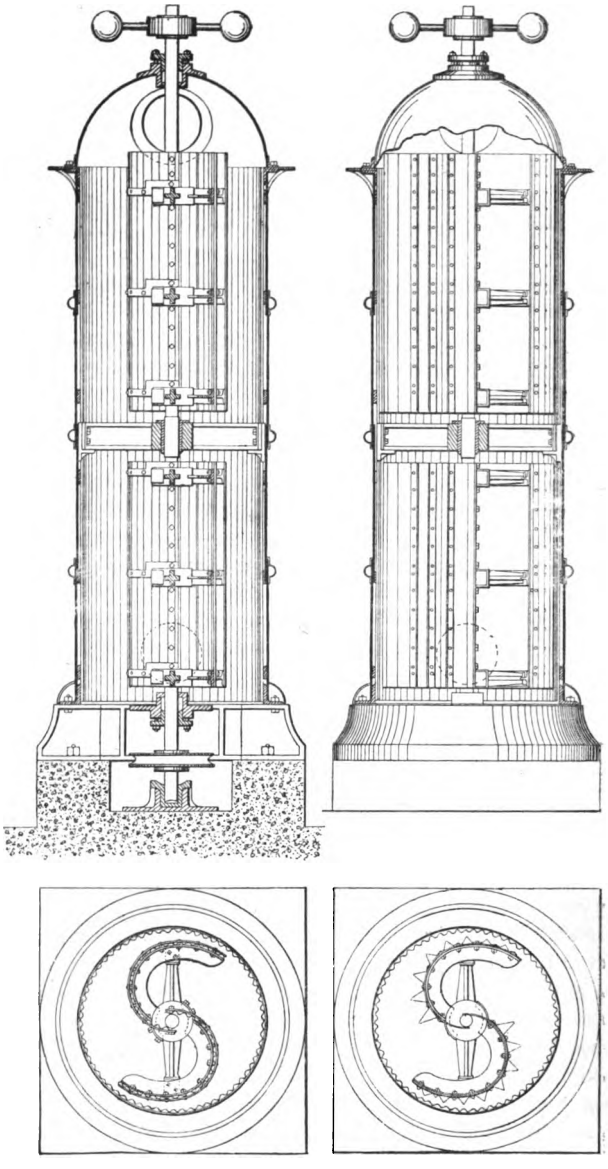

No. 1. No. 2.

FIG. 8.—KEY'S SCRUBBING, CONDENSING, AND WASHING APPLIANCES.

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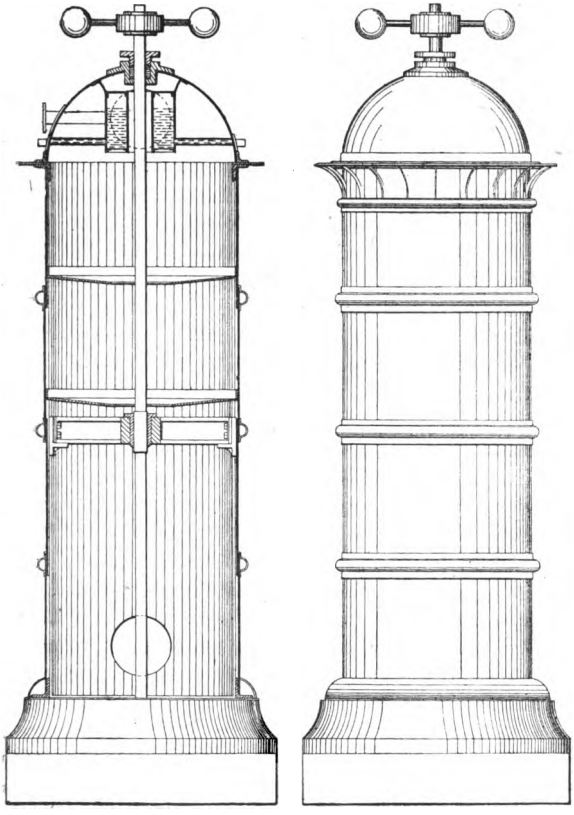

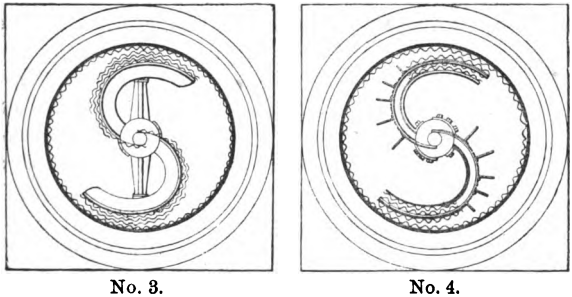

No. 3. No. 4.

FIG. 9.—KEY'S SCRUBBING, CONDENSING, AND WASHING APPLIANCES

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is the only true principle onwhich to construct what would be an effective condenser; but I may be privileged on another occasion to deal with the design of condensers. Meanwhile, it is enough if I say that apparatus for the cooling of coal gas, to be effective, must, in the hands of the manager of the works, be under perfect control; and not like the annular condensers, allow the temperature of the gas to be so influenced by a sudden outburst of sunshine as to cause the thermometer to register an increase of 30° Fahr., or during a day of rain a lowered temperature by 20° or 30° Fahr. The apparatus should be so constructed, that one-fourth, one-half, or three-fourths of it may be thrown out of action at will. Some to whom I have spoken have objected to this because of the first cost, and no amount of argument could persuade them that a careful study and watchfulness over the temperatures would enable them to save their first-class coals, and to work with a cheaper variety, and thereby the whole first cost of a proper condenser would be saved in one winter. Each section of condenser should have a series of thermometers and moveable discs encased in glass, to show at a glance the temperatures and position of the controlling appliances, which, in the hands of the manager, would be adjustable week by week, day by day, or even from hour to hour if necessary; and by the application of a system of levers to control the whole without in any way altering valves or gas passages, unless when a change of surface, by putting in or out of action a section of the condenser, is required. An apparatus of this kind must not have the error of all vertical apparatus now in use—that of the air which comes in contact with the lower portions becoming heated and ascending, and getting more heated as it rises in contact with the pipes or surfaces—extracting less and less heat from the apparatus as it reaches the top; so that in our very variable climate, in all weathers, sunny, showery, frosty, or mild, and in all conditions of the manufacture, be it large or small, the condensing apparatus should be adjustable to all variations, and in the hands of the engineer be controllable to a steady outlet temperature of 60° Fahr.

In works where the gas is still maintained at an illuminating power of anything above 20 candles, the adoption of the scrubbing process just described, and so clarifying the gas before it enters the condensers, will enable the gas to be manufactured much more cheaply; and the greatest benefit will be obtained by those who fix upon a standard of higher illuminating power. In such works, by the employment of the old method of condensation, the most serious depreciation in the quality of the gas would be experienced. The hydrocarbon and other vapours that it is desirable should be taken from the gas as

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soon as possible after leaving the retort having been extracted by these scrubbers, the condensers will now properly perform their functions, in simply cooling the gas from 160° or 120° down to 60°; and they will remain one of the cleanest portions of the apparatus in a gas-works. The exhausters will also be freed of gritty and tarry matter. By passing the gas too hot into the washers, the ammonia to be extracted is apt to remain in the gaseous state; and when the liquor gets heated above 70°, it loses much of the power of absorption from the loss of affinity which water has for the ammonia at lower temperatures. The temperature of the gas is reduced in the condensers to 60° in order to better prepare it for being passed on to the washers.

Washing.—The washer is an apparatus wherein water is employed to wash the gas. The water may be quiescent, and the gas caused to bubble up through it; or the water may be pumped up, or by other motive power made to drip through the gas as it passes through the vessel; or wetted surfaces may be rotated and exposed to the passage of the gas—all with the object of eliminating the ammonia and other impurities. Many managers have experienced in both mild and severe winter weather, a state of things whereby the washers act as condensers; and the liquor in the tanks rapidly becomes coated to a considerable depth with naphtha. The apparatus I am about to describe—in conjunction with the scrubber and condenser arrangements just mentioned—is designed so that the temperature of the gas would be prevented from being unduly cooled, and also the passage of any tarry naphtha to the washers would be an impossibility. The liquor would be made to do a maximum amount of duty; and the quality of the gas will not be impaired in passing through the water.

I have here an apparatus to illustrate the effect produced on illuminating gas by its coming into contact with oil, and before proceeding further will show it in action. The vessel is about 2½ inches in diameter and about 1 foot high, filled with small pebbles. I will now light two jets of equal size and brilliancy. The gas to supply one of them passes up through this small apparatus; and the gas to supply the other is branched off from the supply-pipe to it. Having now poured in the U-pipe by the filler a small portion of this crude heavy dead oil, obtained from the Clippens Oil Company's works, you will be enabled to at once observe how the flame of gas at the jet on the small scrubber has almost entirely lost its luminosity, although the shape and size of the flame remains as large as before. The gas having transferred its richest light-giving hydrocarbon vapours to the oil, of course the oil is increased in volume just to the extent of the vapour

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extracted from the gas. This same thing occurs in the washers, and with the present form of condensers, especially in frosty weather; and the loss of the light-giving properties of the gas requires to be made up by an increase in the quantity of high-class coals used, which will often, in a single month in midwinter, represent a sum equal to the value of the whole plant employed in washing the gas. The gas, in passing through the washers and scrubbers as at present constructed, is exposed to an enormous condensing surface, and the temperature of the gas, which had left the condensers at 60°, will now be found at 40° or even lower than 35° Fahr. In frosty weather, the contact of gas rich in hydrocarbon vapours with the oily and tarry surfaces of the scrubbing liquor as it passes through the vessels at this low temperature tends to, and does cause the quantity of tarry naphtha in the vessels to increase with the result that the illuminating power of the gas is reduced in the same ratio.

Everyone is familiar with the beautiful display of prismatic colours resulting from the letting one drop of tar fall on to the surface of water; and you have doubtless frequently wondered at the enormous surface one drop will cover. This film of oily tar on the surface of the water is very thin; yet the water under it has received a coating which prevents contact by air or gas. If the liquid so coated be ammoniacal liquor, such a film would prevent the escape of ammonia. If coal gas therefore be admitted to the washers in an imperfectly cooled, or in an unclarified condition, the drops of water dripping through the vessel, or the wetted surfaces which the gas meets with in its course, are instantly coated with a film similarly to the water just mentioned; and the efficacy of the ammoniacal liquor for further extracting ammonia and sulphur compounds from the gas is impaired. Hence perhaps the most valuable result from the adoption of my suggested system of scrubbing and condensing will be found in the increased efficiency of the washers.

You all know that if a drop of water is broken up into numberless fine particles, such as mist or spray, thousands of times more surface is exposed on such a condition as compared with the surface of the drop. From this it is plain that, to get the greatest amount of work from water, instead of allowing it to pass through gas in drops or small streams, each drop in falling only making an imaginary line through the gas (just as you would draw a vertical line on paper by means of a ruler), these should be dashed into spray, so that the largest possible surface should be exposed to the gas.

I have designed a washer which will not only prevent the

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excessive cooling of the gas, but will by its powerful application in a comparatively small space, permit of the rapid passage of the gas and the maintenance of the temperature at the outlet as near 60° as possible; and the gas will flow through the liquor that is lashed into foam or fine spray. The apparatus is shown in vertical section and cross section in No. 3. This washer itself is very similar in design to the scrubber, but has fixed to the crown, on its underside, an annular water-tank and air vessel, to which are attached ten tubes, radiating from the tank and passed through the sides of the cover to afford access for cleaning the numerous small holes in them and in the bottom of the tank. Through these holes the water falls on to the revolving corrugated iron fans or wipers. By these the water is at once lashed into fine foam or spray, and with the gas is whirled round the corrugations of the lining of the case; and the gas will be struck by the wetted surfaces of the corrugations of the fans or wipers about 200 times ere it reaches the outlet—the centrifugal action causing the gas and spray to rapidly whirl through the wiper corrugated passages outwards. I have arranged a series of bevelled trays, whereby the gas from a lower chamber in passing upwards into the next higher one has to pass through a 20-inch opening in the centre; and the water in falling from a higher chamber to a lower is directed by the bevelled plates to the same opening. These plates have a large number of small holes, through which a portion of the water will drip on to the revolving wipers.

From the foregoing, the following claims have been brought before you as the object of my paper:—(1) That the crude gas should be led while as hot as possible, direct from the retorts to the scrubbers. (2) That a scrubber, somewhat after the design I have submitted to you, should be employed to scrub the gas perfectly clean from the tarry hydrocarbon and other vapour which it is desirable should be eliminated from the gas before it enters the condenser. (3) That the condensers should be employed solely as coolers, and not used as tar extractors. (4) The gas having first been clarified by the scrubbers, the condensers will remain clean if so used. (5) That the condensers, to be efficient in the hands of the engineer at the works, must be adjustable to alterations in the manufacture and variations of temperature; so that a steady outlet temperature of 60° Fahr. be maintained. (6) That, by these arrangements, the gas will be of higher illuminating power by its passage through the condensers in a clean state, in place of the tarry condition as at present; especially so will this be the case where the gas in the condensers has been allowed to fall to a temperature approaching that of the atmosphere in severe winter weather.

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(7) That by the scrubbing process and clean cooling of the gas, the washers will receive the gas in a condition to enable them to do a maximum duty. (8) The ammoniacal liquor will remain clean; and the liquor will be the more easily worked up to the desired strength. (9) The quality of the gas will not be destroyed as at present by contact with the oily and tarry surfaces of the liquor in the washers in winter.

Discussion.

Mr. J. DONALDSON (Lochwinnoch): I think the thanks of the members are due to Mr. Key for his able paper, dealing as it does with an entirely new departure in gas manufacture. I consider that the plan of taking the tar from the gas before it enters the condensers is a valuable one, and that a very great saving will be effected by so doing. It should recommend itself to all gas managers. As Mr. Key would have shown by his experiment, if the temperature of the room had not been so high, the illuminating power of gas is depreciated by coming in contact with cold oil; and by his arrangement this would be much reduced, and the gas kept up to the standard illuminating power with a much less quantity of rich coal. This is no new idea of Mr. Key's, as he mentioned it to me more than a year ago.

Mr. P. WATSON (Stirling): Is this a patent?

Mr. KEY: No.

Mr. WATSON: Is it working anywhere?

Mr. KEY: It has only been working on the small model I have shown you.

Mr. A. MACPHERSON (Kirkcaldy): We are obliged to Mr. Key for his excellent paper, and for the exceptionally fine diagrams with which he has illustrated his remarks. I have had a notion that for a long time it has generally been recognized that it is wise to separate the hot gas from the tar as soon as possible, and not allow them to travel together, as the illuminating power is thereby deteriorated. Mr. Key's proposal, therefore, is nothing new. In regard to the scrubbing arrangement, I think it is a good one. I do not mean to say that Mr. Key's apparatus is the best that could be adopted; it is the principle I am speaking of. Some years ago, when Mr. Miller, of Innerleithen, brought the subject before us, he worked on the same principle. He had converted a large disused tank into a sort of settling-pit, where the gas was allowed to settle, and the tar to drop. I have no doubt this "whisking" of the gas will have the effect he says the machine will have, of extracting a large proportion of the tarry particles from the gas before it passes on.

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Then in regard to the condenser, there is no doubt that if he keeps his condenser pipes clean by extracting the tar, he will have far more effective working from his condenser than if it were to become coated inside with tar. The condensing of gas is a thing that does not receive sufficient attention. The condensing apparatus ought to be thoroughly under the control of the manager of the works. I can maintain my illuminating power by watching the temperature at which the gas is being discharged at the outlet of the condenser. In this respect, Mr. Key is bringing forward a principle which is well known to us, but which is perhaps not acted upon so fully as it might be. I know a number of people who would rather have a low temperature at the outlet of the condenser, at the expense of the illuminating power, than measure the gas hot. An apparently large leakage account is sometimes no loss, but a profit. By reducing the temperature of the gas to perhaps 30° or 40°, we effect a saving on the register of the station-meter, but at the cost of the illuminating power of the gas; so that it is really no saving at all. Though you have a higher leakage account, it may not be a loss but a gain. The temperature at which the gas is discharged from the condenser is, I consider, a most important element. In regard to the scrubbing arrangement, I am not quite sure that it will be effectual. There will be a certain amount of tarry matter carried forward; and I am afraid the corrugated sheets will become clogged up. Mr. Key's apparatus reminds me of Mr. Whimster's washer turned upside down, or that of Mr. Reid, of Leith. It is a little varied in construction, but the principle is the same. There is no doubt that, in purifying gas, intimacy of contact between the washing material and the gas is the main thing before we can hope to accomplish the object at which we aim. If this is effectual, and gives us intimate contact, the machine will be successful. In regard to the failure of Mr. Key's experiment, I do not see how he could expect to have success, because he tells us he took the oil from the inside of the gasholder. Consequently it must be fully saturated with hydrocarbons already. Instead of reducing the illuminating power, I think he should increase it. Of course, if you put in oil from an oil-works it will be different. I know nothing worse for reducing the illuminating power than a fine naphtha tar in the bottom of the washer.

Mr. G. R. Hislop (Paisley): With a great deal of what Mr. Key has said I agree; but there are various opinions entertained on some of the points he has brought under discussion. There is no doubt that this is a new feature in washing gas. In my opinion, it matters little where you get rid of the solid particles, if you do get rid of them within the usual limits. There is

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no doubt about the damaging effect of some condensers on the illuminating power of the gas; and for this reason we have long ceased to put up condensers in the old form. We have pipe condensers; but they are different from what is known as the ordinary pipe condenser. The pipes are set in rows, and closed in a tank at top and bottom; and as they are made exactly level, the water runs down the pipes, and they are kept as clean as if they had been washed with a brush. That is the form of condenser I have adhered to for a long time. I agree with Mr. Key as to the effects of tarry matter in the other form of condenser, and therefore I have discontinued its use. I make it a point to have the temperature of the gas carefully examined. It will be found to be a great advantage to maintain the temperature as high as possible, even at the risk of losing a quantity of ammonia. The benefit of maintaining a high heat is great, because the hydrocarbons are deposited in the main, and they are largely lifted up again and carried away. What is deposited in the colder weather is thereafter largely taken up again. It is important to keep the temperature as high as possible, consistent with taking the impurities out of the gas on its way to the station meter. I aim at keeping it at 55° in winter; and it is a rare occurrence if it goes down to 50°. From the time the gas leaves the condenser until it gets to the end of the scrubber, I lose perhaps 15°; so that were I to take observations at the end of the condenser, my gas would be seriously deteriorated before it reached the end of the scrubber.

Mr. J. M'Crae (Dundee): The first thing that occurs to me is that we ought to be indebted to Mr. Key for the manner in which he has brought this subject before us; but although we may admire his diagrams, that is no reason why we should adopt his theory without examination. I ask what benefits are to be derived from adopting this process. Has it been worked in any place? Is it not a fact that this corrugated iron will be seriously affected by the foul gas passing along? Will this corrugated iron not be filled up, so that you will have two smooth surfaces rubbing together? In regard to the placing of the scrubber before the condenser, it is like putting the cart before the horse. We have all learned that the gas should be gradually lowered in temperature, and that the temperature should be noted at certain points with care and regularity. I presume this is done in all well-managed gas-works. Mr. Key censured the adoption of annular condensers. I do not see the force of that. In my opinion, there is no part of the process of gas manufacture so little known to the gas engineer as the effect of condensers on the heavy hydrocarbons contained in coal gas; and I question whether we, after

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leaving this hall, shall be very much further enlightened by what we have heard. He has been severe on annular condensers. On an engineer who has erected annular condensers this falls heavy. What is the meaning of a condenser? Do you not depend upon the weather; and must not the condenser be affected by the temperature prevailing at the moment? It is quite true that in winter you must use means to check excessive condensation. This is done in all well-regulated works. The temperature is taken into account; and the moment you go below 70°, you close the sluices of the internal pipes of the annular condensers, and thereby the condensing power is reduced, and the gas kept at an equal quality. I should like to know the cost of this apparatus as compared with the annular condenser, and also to be informed what is to be gained by using it. We should know how far, and to what extent, the various temperatures affect the illuminating power of the gas. A very important difference exists here, and it is not commonly known; but it is well that it should be understood. For example, if you, with a certain mixture of coal, supply 26½-candle gas in the summer time, what quality of coal would you require to use to supply a similar quality of gas in the winter time? This is a point which many have overlooked; and it demands much consideration. It is well known that excessive temperature, either high or low, has a decided effect on coal gas; and the question ought to be suggested for solution to some gas manager who has the means of ascertaining what that effect is. Some years ago, another Gas Association took up this question; but I do not know that very much good came of their investigation. I think some definite results might be arrived at, and information obtained which would be important to us all.

Mr. A. Smith (Aberdeen): It should be borne in mind that there are a great number of annular condensers being erected; and unless Mr. Key has something definite on which to condemn these appliances, I do not think he should have brought the subject so prominently forward. The annular condensers occupy much less space than the pipe condensers; and you have the same power over the one as over the other. I think a number of condensers should be thrown out of use during the cold weather. From the discussion of this paper, I do not consider we should run away with the idea that there is no condenser right, but the one adopted by Mr. Hislop. That would be most absurd. Mr. Key's diagrams of his scrubbers are very beautiful. But I am a good deal of the opinion of Mr. M'Crae, that you must have means for washing them out; and my experience is that the simpler you can make apparatus for gas manufacture and purification the better. To

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my mind, Mr. Key is, in this respect, taking a step in the wrong direction. I am not so sure that driving the gas at the rate of 800 revolutions a minute is calculated to improve it. If this is found to be good, a jet of steam would clean the corrugations. Although I cannot agree with Mr. Key, I thank him for bringing forward this subject. The discussion proves that we could have spoken with more effect if we had had the paper in our hands for study before coming to the meeting.

Mr. HISLOP: I hope Mr. Smith will not go away with the idea that I hold that there is nothing in creation like the condensers I have. I simply stated what I had adopted in preference to other kinds. Many of these things are merely matter of opinion; and I simply put forward my ideas on the subject.

Mr. MACPHERSON: Mr. Smith included me as one of the condemners of annular condensers. I did not condemn them, because I think that properly constructed annular condensers can be as well controlled as any others.

Mr. S. STEWART (Greenock): I quite approve of what Mr. M'Crae and Mr. Smith have stated as to the use of annular condensers.

Mr. KEY: The object of my paper was to raise a discussion; and I am pleased with what has taken place, because it was for the purpose of obtaining an improved method of conducting our business that the paper was prepared. Mr. MacPherson agrees with me as to the temperature to be maintained throughout the apparatus; but when he comes to the washer, he expresses the fear that it will become clogged. That is an utter impossibility, as the water and the clean gas can never clog up the corrugations by this arrangement.

Mr. MACPHERSON: We have had examples of clogging in other things.

Mr. KEY: At 60° it is an impossibility; but if you go down to freezing point, you will have naphthalene. As to the form of the washer, Mr. MacPherson says it reminds him of Mr. Whimster's or Mr. Reid's; but they are not at all alike. The principle of Mr. Whimster's is a system of boxes; and Mr. Reid's is a long vessel with a revolving cylinder, and having a number of trays lifting up water, which percolates through to the gas. I say that it is spray hat is wanted, and not drops of water. Anyone looking at it will see that there is no resemblance to either Mr. Whimster's or Mr. Reid's plan. Mr. MacPherson thinks the oil may be expected to enlarge the flame of the gas; but I am perfectly certain that, when at a low temperature, the oil will depreciate the gas 50, 60, or 80 per cent. I shall keep some of this oil for the purpose of making some further experiments; and perhaps you may hear of it again.

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Mr. Hislop seems to think it does not matter how or where we get rid of the tarry particles, so long as we do get rid of them; but I hold that we should remove all the tarry matter from the gas before we pass it into the condensers. I propose to take it out before it enters the condensers, leaving the coolers and condensers to do their own work. Mr. Hislop agrees with me about the annular condensers. Others may have different methods of arriving at their conclusions. I have noticed the thermometer inside an annular chamber go up when the sun rose; and I have seen it go down 20° in five minutes in a shower of rain. The condenser I recommend is something we can go by—something we can regulate by the movement of a lever. Mr. Hislop also agrees with me about maintaining the heat, and as to the loss of temperature between the condensers and the scrubbers. He has told us it often loses 15°—just what I stated in my paper. Mr. M'Crae has asked what benefit will be derived from this arrangement. I cannot give the benefit in pounds, shillings, and pence; but I have formed a very good opinion of the loss sustained under the present system. I say that at least 10 per cent. of the value of your coal will be saved every day during winter by this arrangement. What other benefits will be derived can only be found out when the system is put into operation. As to the choking of the corrugations, I say it cannot be, because, with gas passing in at from 120° to 160°, such a thing as any solid matter being there is an impossibility. The liquor I obtained at the outlet was very liquid indeed. I agree with Mr. Smith that it would be much better if the members had the papers before the meeting.

The PRESIDENT: While thanking Mr. Key for his paper, I must say that it would have been of much more value had he given us some practical results. The pound of theory has been very much in vogue; but what we want is the ounce of fact. If the apparatus had been put to the test, and some facts given after it had been in use, it would have been much better for us all. Mr. Key has spoken of having had his ideas "in pickle" for a number of years; it would certainly have been better if he had put them in operation. We have for some months been working with an apparatus at Dawsholm, but do not mean to say anything about it until we are able to state something definite. It was premature on the part of Mr. Key to give us only theories; he should have waited until he could show us actual results. The 10 per cent. saving of coal on which he reckons it appears to me is merely a matter of assertion. It is easy enough to say such a thing; but if there is nothing to support it, it would have been far better if it had never been said. We have now come to the end of the list

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of subjects for discussion; and I ask you to accord a hearty vote of thanks to the readers of the various papers. They have added very much to the success of the meeting. The suggestion as to the papers has already been considered by the Committee, and it may come up again.

The President's Medal.

Mr. J. M'Crae (Dundee) said that there were two very pleasant features characteristic of the Scotch gathering of gas managers. In the first place, the meeting was always agreeable; and, in the second place, its end was always pleasant. They had come to the close of one of the best meetings the Association had ever held; and a very pleasing duty had fallen on his shoulders, to present Mr. Terrace with the highest honour the Association could confer on him—viz., the presidential gold medal. It was not alone the intrinsic value of the medal, but it was something to hand down to one's children, to show the estimation in which he was held by his brethren in the craft; and he was sure no one who had preceded Mr. Terrace had more worthily earned the distinction than their present President. With these remarks, he asked Mr. Terrace's acceptance of the medal, assuring him that every member of the Association, absent as well as present, wished him many years of happiness and prosperity.

The President thanked the members for their great kindness in awarding him the medal, and Mr. M'Crae for the happy manner in which he had expressed their sentiments in presenting it.

Vote of Thanks to the Secretary.

Mr. Hislop proposed a vote of thanks to the Secretary, for the energy and ability he had displayed in conducting the affairs of the Association.

The proposition was carried with applause.

Mr. Carlow, having returned thanks, the business of the meeting concluded.

In the evening the members and their friends dined together in the Royal Bungalow of the Glasgow International Exhibition—Mr. Terrace presiding. After dinner some time was spent in viewing the exhibits. On the following day an excursion was made from Glasgow to Loch Lomond and Loch Long.

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NORTH OF IRELAND ASSOCIATION.

FIRST ANNUAL MEETING, AUG. 14.

This Meeting was held in the School-Room, Railway Street, Lisburn—Mr. E. STEARS, of Lisburn (the President), in the chair.

The HONORARY SECRETARY (Mr. J. Whimster, of Armagh) read the report of the Committee for the past year and the statement of accounts; and they were unanimously adopted.

NEW MEMBERS.

Three gentlemen were then admitted as members—Mr. J. Gibb (Newry) as an ordinary member, and Messrs. Walter King (London) and R. Johnstone (Edinburgh) as extraordinary members—on the motion of Mr. R. Ross (Dungannon), seconded by Mr. R. MERRILEES (Castleblayney).

ELECTION OF OFFICE-BEARERS.

The next business was the election of office-bearers and Committee for the ensuing year.

The SECRETARY remarked that the Committee had decided to name as President for the ensuing year Mr. Featherstone, of Dundalk; and in accordance with that decision, he (the Secretary) had great pleasure in proposing Mr. Featherstone's election.

Mr. R. Ross (Dungannon) seconded the motion.

No other candidate being proposed,

The PRESIDENT declared Mr. Featherstone unanimously elected.

The SECRETARY said he begged, on behalf of the Committee, to submit the names of the following gentlemen as members of the Committee for the ensuing year:—Messrs. R. Ross (Dungannon), J. Nisbett (Portadown), J. Mearns (Banbridge), A. Waddell (Newtownards), T. Frizelle (Holywood), and A. Gibb (Newry).

On the motion of Mr. J. ROBB (Limavady), seconded by Mr. R. MERRILEES (Castleblayney), these gentlemen were elected.

The SECRETARY said the only remaining question was that of the election of a Vice-President. On this matter the Committee had not come to any decision, and were not prepared to make any

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recommendation. They thought that perhaps the Association could manage to do without a Vice-President until they got into working order. Then there was the question of a Secretary and Treasurer and also of an Auditor. For the last-mentioned position the Committee suggested Mr. J. Todhunter (Ballymena).

Mr. A. WADDELL (Newtownards) proposed that Mr. Todhunter be elected as Auditor.

Mr. W. NISBETT (Aughnacloy) seconded the motion, which was unanimously carried.

Mr. R. Ross (Dungannon) said the only office remaining to be filled up was that of Secretary and Treasurer; and it gave him great pleasure to propose that Mr. J. Whimster, who had rendered such valuable assistance in establishing the Association, and who had from the beginning discharged the onerous duties of Secretary and Treasurer in a manner that entitled him to their warmest thanks, be re-elected to the position for the ensuing year.

Mr. W. R. FEATHERSTONE (Dundalk) was pleased to be permitted to second the resolution; as he thought they could not have a better gentleman for their Secretary than Mr. Whimster.

The resolution was unanimously adopted.

PLACE OF NEXT MEETING.

The SECRETARY then proposed that the next meeting of the Association be held at Dundalk.

Mr. R. Ross seconded the proposition, and it was agreed to.

The PRESIDENT next proceeded to deliver the following

INAUGURAL ADDRESS.

Gentlemen,—In commencing this brief address, I must thank you for having chosen Lisburn as the first place of meeting of our newly-formed Association, although I am afraid I cannot show you here anything novel in the operations connected with the manufacture of gas. I find, as a rule, that directors do not like to try new schemes which are likely to cause any additional expenditure; but they prefer to continue working on the old lines. Perhaps, if their dividends were to fall below 10 per cent., they would be more speculative.

In the North of Ireland, gas companies have (like many others) found it necessary to their welfare, in face of the competition of electric light and petroleum, to reduce the price of gas. The best means of maintaining the value of our property is by keeping the price of the commodity we supply as low as will pay a fair dividend, as there is no question that the competition of petroleum and electricity with gas is very sharp. As far as Lisburn is concerned, we find that very few new customers are obtained from small

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private houses with a rental up to (say) £20 a year. They nearly all consume oil, although the price of gas is only 3s. 9d. per 1000 cubic feet. One thing which operates against my Company procuring the custom of the poorer class of residents, is that we require a deposit of 10s. as security. This no doubt reduces the amount of bad debts; but it is detrimental to an extension of our business. In regard to the electric light, we have one mill in our district partly illuminated by this means; and I must say that it seems to give satisfaction. The owners of another mill are also seriously contemplating its adoption in an extension of their premises; and the promoters of the light say that the cost will be much less than gas. There is no doubt that there is more danger of our mill customers going over to electricity than the general public, as they can supply motive power and supervision at low cost.

I intend making a few general remarks on gas manufacture from my own point of view, and hope that these will meet with approval. I may here incidentally remark, as some of our members may not be able to be present to-day, that we manufacture 26 million cubic feet of gas per annum; the maximum make being 160,000 cubic feet per 24 hours. As nearly half our make of gas is sold to mills, the heaviest output is in the winter months. Dealing first with the retort-house, our retort-benches consist of sixes, set on Cathels's system. The only alteration I have made is in the furnace. I use cast-iron bars 2 ft. 6 in. long, the furnace 12 inches wide, and double doors; thus giving a deep fire, and generally allowing some air to pass in through a sight-hole left partly open over the furnace. I take the opportunity here of suggesting to those members who may have had some experience with regenerative furnaces, that we shall be glad if they will give us some information on this important subject.

In regard to the question of tar burning, I have tried this both with and without steam, and must say that I prefer the latter plan, as it does not give such intense heat in the furnace, and also causes less trouble and noise in working. The tar-supply tank is fixed outside the retort-house, and is filled with tar from the well by an injector, at the same time permitting the tar from the pipe leading from the hydraulic main to flow into it—the overflow going back again to the same main lower down. I found some difficulty at first in getting this plan to work. This, however, I overcame by introducing a gas-burner in the wooden box where the tank is situated; and by keeping the temperature up to 70° Fahr. I have not had any trouble on this point, and do not find it necessary to use screens to keep out the dirt. My experience leads me to the conclusion that 2 gallons of tar are about equal to a bushel of

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coke. I may mention that the tar was used in the ordinary furnace. The fire was allowed to clinker up, and only a sufficient opening left to consume the tar and its products with a few bushels of coke daily. We clinkered the fire out perhaps once or twice a week. When burning tar, the upper furnace-door is substituted by one having four 1-inch holes drilled through it for the air supply.

As to the exhausters, we have three—one being a Laidlaw or rotary exhauster, and the others a Beale and a steam-jet. The latter is made of 1½-inch pipe, which is sometimes used for six retorts in the summer. For general use, I prefer Laidlaw's exhauster, as it costs less for lubrication and attention, although the amount of "slip" in it is very large. It answers well for all but the heavy work, when there is a strong back pressure, and then Beale's is more suitable. For Beale's exhauster we use creosote oil, which answers the purpose well, and is cheap. After leaving the exhauster, the gas passes through an ordinary scrubber, worked with ammoniacal liquor; and we are now fixing also one of Kirkham, Hulett, and Chandler's "Standard" washers to work with water. The gas is then purified with lime in the ordinary way.

It may be in your recollection that we had an explosion during last winter. It took place at 4 o'clock in the morning, just as the men had finished the 3 o'clock charge. It was caused by a seal-cup at the bottom of the centre-valve blowing; the lime in the purifiers being too dry, which caused more back-pressure than the seal-cup would stand. The flooring of the purifying-house being boarded over, the hollow space below became filled with gas; and it eventually caught fire from a lamp in the yard. Four men were taking water to fill a syphon which it was thought was unsealed, when the explosion took place blowing the men away and unslating the purifier-house, besides doing other damage to the works. Fortunately, the only injury to the apparatus was a crack across the bottom of one of the purifiers. The men were taken to the infirmary, where they were under care between two and three months; the Company paying them full wages during the whole time.

I have this summer fixed a hydraulic safety-valve to the inlet of the scrubber, consisting of a covered tank 3 feet deep by 14 in. by 12 in., with a division 2 inches from one side going down to within 3 inches of the bottom. The working pressure is regulated by a ¾-inch pipe for overflow at the water-line; the inside of it being carried 6 inches downwards, so as not to be affected by the ebullitions of the water when in action. There are also two rows of tiles

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laid partly across the inside of the chamber, 6 inches and 9 inches above the water-line, to check the ascent of the water, as it is thrown upwards by the gas. A 4-inch pipe conveys the gas to the top of the scrubber; so that in case it operates, the gas will be blown into the atmosphere out of danger. The gas-inlet is in the 2-inch chamber; and the outlet-chamber being larger, will prevent so much water being blown out of it through the overflow when put in action. I made 4-inch connections to this valve, which I considered large enough to take off the make of gas in case the inlet to the gasholders should be closed by accident; and thus preventing the purifier lutes blowing, and not allowing too much gas to flow back from the gasholders in case the holder inlet-valve was open.

We have manufactured sulphate of ammonia at our works for about twelve years. I believe I may claim to be the first in this district to do so. The apparatus employed I may describe as "home made;" the capital outlay being under £100. All the tanks, including the saturating-tank, are lined with sheet lead 6 lbs. to the foot. The saturating-tank is lined with lead in one piece, what the plumbers call pig lugged—*i.e.*, the ends are turned up. The joints of the other tanks are joined with coarse solder. The liquor is pumped into a tank supplying the boiler by the same pump that supplies the scrubber. The boiler is fired with breeze. There are then a saturating-tank, two settling-tanks, and two evaporating-tanks. The liquor is heated by the waste steam from the engine after it has passed through a water-heater for the boiler feed. The man who sells coke makes the sulphate of ammonia, with the aid of an assistant, in the winter months. When I commenced the manufacture, the salts were made in the saturating-box; but it was found more convenient to make it by working the saturating-box with half water and half acid at starting, and then removing the neutralized liquor to the settling-tank, and from thence letting it down to the evaporating tank below. This plan enables the man in charge to leave the boiler filled with ammoniacal liquor at night, having made up the saturating tank with sufficient acid and water to neutralize the steam from the boiler; so that all the night stokers have to do is to keep up the fire, and shut the damper and lift the safety-valve when the water gets to a certain level in the gauge. We generally make about a ton of salts to every 110 tons of coal carbonized. I have given these details, as there may be some manager who may be under the impression that it requires a large outlay to set up sulphate works. I may say there are no brick buildings connected with the apparatus, and the tanks are under wooden sheds.

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With regard to the question of wet and dry meters, I may say that I am an advocate of the latter—in fact, for the last five years we have not bought any wet meters. The consumers always prefer the dry meters, as they give less trouble. As to our street lamps, they are all provided with governors. I should strongly advise those managers who have not adopted governors to do so; and I can assure them that the results will be not only a much more satisfactory light, but a saving of gas.

I have upon several occasions met with managers of small works who, upon my inquiring what pressure they supplied at during the night, could not tell me, as there was no pressure-gauge on the works. The general plan seems to be to put the gas on full at night. Those who have (say) a 4-inch valve which they open and shut, should have a 1-inch or ¾-inch governor acting as a bye-pass round the valve; and so work the night pressure after eleven o'clock and the day pressure with it. By having a pressure-gauge on the outlet, the pressure can be reduced from (say) 5-10ths inch in the daytime to 1 inch after 11 p.m., instead of allowing the gasholder pressure to remain on the town all night.

The question of Sunday labour in gas-works has recently received much attention. In our case we give the day stokers a half holiday —that is, half the men come to work at six o'clock, and go off after the twelve o'clock charge is finished; the other half remaining during the afternoon. The men receive full day's wages. The work is generally eased on Sundays by laying off a bed or two according to the state of the gasholders.

In conclusion, I may observe that in my opinion it is not unlikely in the future we may find large works adopting a system of manufacturing water gas on the plan advocated by Mr. A. Wilson, of Stafford,* which resembles a cupola used by ironfounders for melting iron, and that a method will be found of injecting gas tar into it, so that a gas of low illuminating power may be used for mixing with ordinary gas, and used for day supply (say) for eight months in the year. There are some gas companies who have a large demand for gas for cooking purposes, &c., and who perhaps are only compelled by their Act to supply 14-candle gas, whereas they generally give from 16 to 17 candle gas. The only difficulty I can foresee, is that at lighting time the consumers on the distant parts of the mains might complain of the low illuminating power of the gas during the early portion of the evening. There is, however, no doubt that a scheme of this nature would require more attention than the ordinary plan of coal gas making, and certainly would not be suitable for small works.

* See *Journal of Gas Lighting*, Vol. L., p. 581, and Vol. LI., p. 1131.

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Mr. FEATHERSTONE proposed a vote of thanks to the President for his very admirable address.

Mr. FRIZELLE seconded the motion, which was carried unanimously.

PAPERS AND DISCUSSIONS.

The SECRETARY said he was sorry to have to announce that Mr T. Travers (Cork), who had promised to read a paper, entitled "How can we best Assist our Consumers?" had written to say that he would not be able to be present. Further than this, Mr. Travers had not sent his communication. However, they had three other gentlemen present who had prepared papers on subjects of importance.

Mr. W. R. FEATHERSTONE (Dundalk) then read the first paper, entitled—

THE UTILIZATION OF TAR.

The low prices offered for tar at Dundalk caused me to use up all my surplus; and, after 18 months' experience, I estimate the value of our tar to be at least 30s. per ton. We have no steam power to spray the tar, yet for weeks no coke was consumed; tar taking its place in the furnaces.

The following extracts from our annual statements of accounts prove the value of tar:—

Cash received by Sales each Year ending June.

	1885-6		1886-7		1887-8	
	£ s. d.		£ s. d.		£ s. d.	
Coke . . .	553 5 2	..	603 14 4	..	795 10 5	
Tar	104 0 4	..	91 15 8	..	150 5 1	
Liquor . . .	28 3 9	..	35 16 4	..	51 11 5	
	£685 9 3		£781 6 4		£997 6 11	
	Tons.		Tons.		Tons.	
Coal carbonized	2943	..	2776	..	2764	

	Tons.
Coke sold without tar burning in 1887	670
Do. with do. in 1888	1015
Increased coke sales in one year =	345

The surplus tar was used in various ways. It was employed for firing retorts; for roadways and footpaths; for the gasholders, in lieu of paint; for mixing with fire-clay, to repair the furnaces, retorts, &c.; and for stopping leaks in the gasholder tank.

In making tar concrete, the material—cinders, stone riddlings, gravel, &c.—should be first drenched with water, and regularly puddled. Then add 1 gallon of tar to 3 bushels of material, and thoroughly mix into a slush. Do not heat either stuff or tar.

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This mixture can be laid at any time in dry weather. For the retort-house, a flooring of tar concrete is hard and clean. It stands heat, rough carts and horses, tipping coals, with the usual turning, backing, &c. After twelve months, it is a decided improvement over the stone paving it replaced, as one man can run 5 cwt. of coal in a handcart with less trouble than 2 cwt. with the old paving. The main flue does not affect it, running underneath. To lay concrete, first get a good foundation by levelling and rolling. Spread the mixture, drench it with water, and roll and pour on water until both tar and water issues out in streams, and a skin forms on the surface. Leave it to dry; then coat it well with boiling tar and 1 pint of paraffin oil to a gallon of tar—about 1 gallon of tar and oil to 5 square yards; then dust it over with sand, and in ordinary summer weather it will rapidly dry, set, and become waterproof. This can be thoroughly well done for from 9d. to 1s. per square yard. For tarring the gasholder, I first scraped off all the old paint, and then coated it thinly with hot tar, thinned with paraffin oil.

To ascertain the daily stock of tar in the yard tank, an old meter-case forms a float, weighted to sink in liquor but float in tar. A staff with a pointer indicates the height of the tar; and, with very little assistance, the float can be raised to the top of the liquor, and thus determine the depth of both tar and liquor separately.

I do not consider it advisable to burn tar closer than 2 feet, or even 2 ft. 6 in., from the point of ignition to the bottom of the retorts, without protection. I make the tar-burner to swing out of the way like an ordinary bracket; and find brass or lead nipples better than iron.

In using tar for firing, I employ the arrangement shown in the drawing. The tar is lifted direct from the yard store-tank by an ordinary force-pump fixed against the wall outside the retort-house, into tanks placed upon the retort-beds, two tanks to a bed, connected direct by 1½-inch pipes along the top of the bed. The tar is supplied to the burners by a ¾-inch service-pipe, taken from the bottom of the tank A. This pipe descends to within 2 feet of

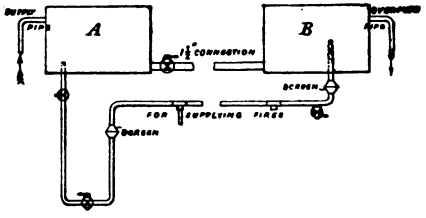

FIG. 10.—TAR-TANK AT THE DUNDALK GAS-WORKS.

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the retort-house floor; then rises where a screen is fixed, and runs along the front of the mouthpieces to a similar screen. But the pipe enters the tank B 12 or 15 inches higher up. Along the front, tees (plugged up) are fixed, to screw on a bracket as required. The advantages of this arrangement are that the tanks can be easily emptied, vapour does not form in the pipes and cause a bad flow, but a circulation is formed; and when the tar is low, the vapours do not block the pipe. The screens cleaning the rising tar do not clog; and the flow can be reversed, and screened tar used to clean its own screen—any sediment being run off at the tap.

The furnaces consume coke only when it cannot be sold, or when the tar is low in the tank. A lump is made with two tiles, banded and packed wedge-shape; and into these grooves are cut for a

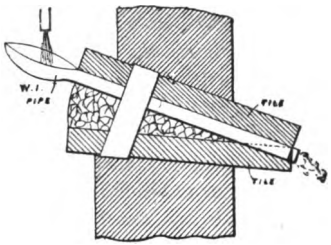

FIG. 11.—TAR-FIRING ARRANGEMENT AT THE DUNDALK GAS-WORKS.

1¼-inch wrought-iron pipe, opened at the end to receive the tar. They are let into the wall over the furnace-door when a coke fire is converted. A coke fire can be turned into a tar-burning fire without any stoppage.

Discussion.

Mr. WHIMSTER said he was very glad to have heard Mr. Featherstone's paper, which was upon a subject of the deepest importance to every member. It was a great thing, in his opinion, to have the means of utilizing tar satisfactorily; and it seemed to him Mr. Featherstone had been very successful in his work. With reference to the portion of the paper which dealt with the use of tar for the making of roads, he was very much surprised at the idea of drenching it with water. He had hitherto believed that it was necessary, for the successful employment of tar in this way, that it should be kept as dry as possible; but he now saw his mistake. He thought this idea of Mr. Featherstone's a very useful one. Again, with reference to the burning of tar, Mr. Featherstone's description of the system he adopted was most interesting; and he (Mr. Whimster) was sure the author had hit upon the right thing in that respect. It was a most reasonable and sensible

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one, and had in Mr. Featherstone's hands worked with most satisfactory results. He was very glad to have had the opportunity of hearing so practical a paper on such a subject; and he was sure the information it contained would be useful to them all.

Mr. J. GIBB (Newry) desired, with the Secretary, to express the pleasure it had given him to hear Mr. Featherstone's paper, which contained a great deal of information that would prove useful to them. The subject was, as Mr. Whimster had stated, one of the very greatest importance to them, because they could get little or nothing for their tar; and it was of the utmost importance to them that they should have a satisfactory mode of utilizing it. The arrangement which Mr. Featherstone had described to the meeting was an excellent one; and the author had introduced several things of which he (Mr. Gibb) had no idea. The arrangement by which Mr. Featherstone had obtained complete circulation of the tar was certainly ingenious, and overcame several great difficulties. He wished to express his appreciation of the valuable hints the paper contained, and which he thought might be taken advantage of by them all with profit. There was one point, however, which he did not catch very clearly when listening to the reading of the paper, and upon which he would be glad of a little more information, and that was exactly how far the pipe from which the tar issued was allowed to project into the air.

Mr. FEATHERSTONE said he had already fully explained in his paper how the tar was introduced into the furnace; but he might say further, in reply to Mr. Gibb's question, that the pipe conveying the tar was put just so far into the furnace that the tar, on issuing from the end, dropped right into the middle of the fire.

Mr. GIBB said he had another question which he would like to have answered, and that was with regard to the smoke resulting from the burning of the tar. He wished to have some information as to the arrangement by which Mr. Featherstone got rid of the smoke, as he did not deal with this matter in his paper.

Mr. FEATHERSTONE replied that the tar burned with a white flame; and there was no smoke from it. Consequently, there was no smoke to get rid of.

The PRESIDENT remarked that the fact that there was no smoke showed that the tar was being consumed.

Mr. FEATHERSTONE said this was perfectly correct. If the fires were all right, the tar was completely consumed; and therefore there was no smoke. It was necessary, however, in order to obtain the complete combustion of the tar, that the fire should be kept up to the proper heat; and the tar burned so brilliantly in the furnace that at night it looked like a star.

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The PRESIDENT said they were all much obliged to Mr. Featherstone for his paper, and also for having answered the questions put to him.

Mr. A. WADDELL (Newtownards) next read the following paper:—

EXPERIENCE WITH MR. G. R. HISLOP'S REGENERATIVE FURNACES.

The regenerative system of heating has, up to the present, received very little attention from gas managers in this country. Indeed, one would think from the results claimed for it by English and Scotch managers who have adopted it, that it would long ere this have obtained a footing on this side of the Channel. But perhaps, we are all too slow to move out of the old ruts of ordinary routine, and adopt the newer methods which the more daring or more speculative spirits have attempted, and in some instances with marked success. It may be that we are all too conservative of what has the stamp of approbation from those who have made gas so successful as an illuminant in the past, and fear to differ from them or cast a reflection on their judgment. Others perhaps may have been deterred from giving the system a trial, lest the cost should exceed the profit; or they may have had serious doubts as to the genuineness of the claims put forward on its behalf. Be that as it may, I think I am safe in saying that the system has not been adopted yet in any part of Ireland, except in Newtownards; and therefore I consented the more readily to give you the result of my limited experience.

Whatever system can show the most favourable results on the year's operations must, of necessity, carry the day. Gas has now two very powerful opponents, each competing for a share of the patronage of the public—electricity and oil. The latter is a very powerful opponent, because of its cheapness; the other, because of its brilliance. Therefore gas, to hold its own, must be produced at the lowest possible price; and, in order to do so, the gas manager must be keeping his eyes open to every improvement which promises a saving of expense or an increase of production I do not know that I can serve the North of Ireland Association of Gas Managers better than by simply telling them what I have done, and with what results.

At the beginning of November last, I had completed the work of taking down two old ovens containing four retorts each, and replacing them by two new ovens with settings of five retorts, heated by Mr. G. R. Hislop's gas producers and regenerators. During the last few years the regenerative system of firing has formed the subject of many instructive and interesting papers

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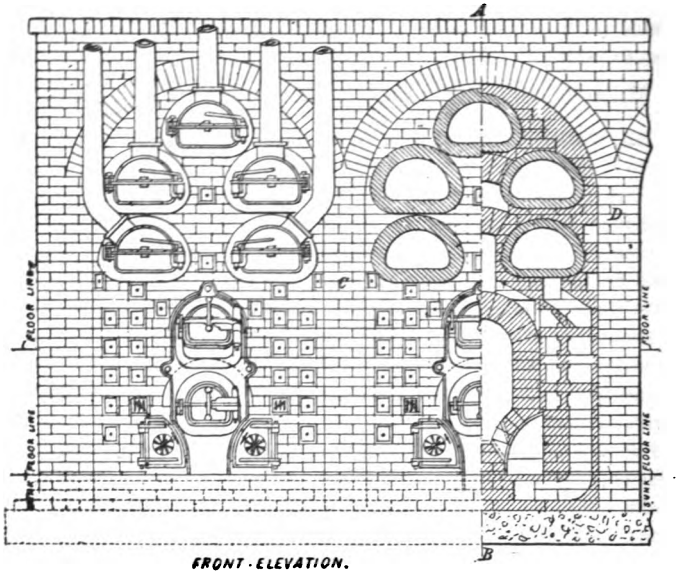

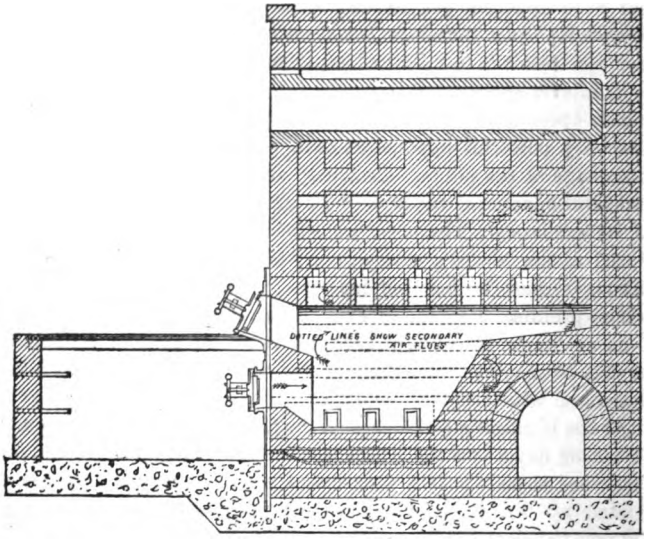

FIG. 12.—HISLOP'S REGENERATIVE FURNACE AT NEWTOWNARDS.

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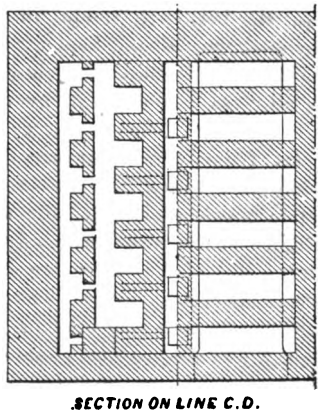
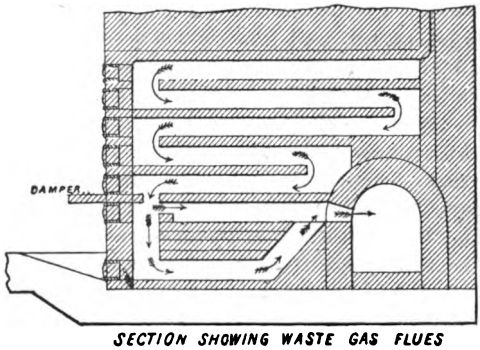


SECTION ON LINE C.D.



SECTION SHOWING WASTE GAS FLUES

FIG. 13.—HISLOP'S REGENERATIVE FURNACE AT NEWTOWNARDS.

read before Gas Associations; and I think you will agree with me that the conclusions to be drawn from them, and the discussions which followed, are that to obtain a uniform heat throughout a setting, combustion must take place not at one part, but along the whole length of the oven, and that it is desirable to take as much heat from the waste gases as economy will allow. Few managers even of large works care to adopt elaborate and consequently expensive regenerators; while managers of small works find the cost absolutely prohibitive. The conclusion, therefore, is in favour of the shallow-chamber principle, such as forms the subject of this paper.

I will endeavour to describe to you, with the assistance of the diagrams, Mr. Hislop's system, so that you may judge how far it

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meets your approval or otherwise. The producer is 8 ft. 6 in. high, 1 ft. 9 in. wide, the bottom 3 ft. 6 in. in length, formed by arches as shown, being supported and kept air-tight by cast-iron plates, each having three port-holes through which primary air passes, after being adjusted (as desired) by discs in air-tight doors. Underneath these port-holes a pan containing water is placed, which has part of the waste gases carried under it, so as to evaporate steam in order to soften any clinker that might form, or to keep it from forming. This saves the expense of raising steam and laying down steam pipes, and only requires a water pipe introduced on the top of the triangular door frames, from which the water drops into the ash pans. The top or arch of the producer is continued the full length of the oven, having port-holes in the centre, through which the producer gases pass into the combustion chamber, and meet the secondary air supply, which has been heated by travelling along flues situated between the producer and the waste gas-flues; passing finally by port-holes into the combustion chamber directly opposite the gas producer port-holes—causing the gases to mix well. The sides of the combustion chamber are formed by the same wall that protects the sides of the bottom retorts, on which arches rest; leaving port-holes equal in area to one-half the top of the chamber, from which the gases travel over and around the retorts and underneath the bottom retorts to the waste-gas flues, heating the secondary air, &c., and thence to the chimney. There is not in the whole building one specially-made brick. The setting is easily built; and every one of the flues can be readily got at if they require cleaning. But this I have had no need to do; the whole setting being quite clean after a season's work.

Some of the advantages of this over the old or direct system of firing, are regularity of heat in the retorts, and greater control over the heat when stopped working, obtained by shutting the dampers and discs. One fire will then last ten or twelve hours; and even then there is heat sufficient to burn off a moderate charge in four hours. This is a great advantage where there is a desire to do away Sunday labour, or in small works where in summer enough gas is made in 12 hours to serve for 24 hours.

In adverting to the results, I may say that we have been able to make at the rate of 8000 cubic feet of gas per mouthpiece every 24 hours—an increase of 60 per cent. as compared with the old system of firing; for then it was difficult to maintain a make of 5000 cubic feet per mouthpiece every 24 hours. We charge the retorts every four hours; fill the producer every three hours; and clean the same once every 12, and sometimes once every 24 hours.

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But as this means only the drawing of ash or soft clinker from the bottom door by a rake, and dropping the contents of the producer (meanwhile held up by a thin arch of clinker, preventing the cold air from entering the oven during the process), this seldom takes more than two or three minutes. The saving of labour is thus very considerable. Judging from the condition of the retorts as they now are, I have good reason to believe that they will last one-half longer than when built in an oven heated by a direct fire. The appearance of the producer and regenerators also justifies me in saying that they will last at least two, if not three, settings of retorts. During the same time, if working with common furnaces, it would have been necessary to rebuild and repair them a dozen times; so that, although the common furnace is much cheaper at first, the expense of rebuilding and repairing it for say six years, would make it nearly as expensive per annum without any of the important advantages.

Since introducing this system of heating, we have made 560 cubic feet more gas per ton than formerly, with 30 per cent. of the coke produced; and I have no doubt we shall be able to do better this year. From the beginning, we have had continued satisfaction; and I would not for a moment think of resetting any retorts on the old plan of firing. My opinion is that this system will continue to force itself upon gas engineers and managers until it becomes universal.

Discussion.

Mr. NISBETT (Aughnacloy) observed that he was sure he was expressing the opinion of everyone present when he stated that the paper they had just heard was a most important one, and the subject one that deserved their very best attention. He had listened with great interest to Mr. Waddell's communication; and had profited very much by the account he had given of Mr. Hislop's regenerative furnace. It was to their advantage to give careful consideration to all the most recent improvements in the appliances for the production of gas with the smallest amount of labour and cost.

Mr. WHIMSTER endorsed the remarks of Mr. Nisbett with regard to the interesting character of the paper they had just heard; but, proceeding to discuss the merits of the regenerative furnace, he remarked that, while he looked upon the make per retort as being pretty high, he did not consider that the use of this particular furnace would result in much saving. There was one matter upon which he would like some information, and that was as to how far below the surface Mr. Waddell had to go in the erection of his furnace. He also wished to know how high the furnace was.

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Mr. WADDELL said he had to go 8 ft. 6 in. below the surface; and he thought the setting was about 14 feet high.

Mr. WHIMSTER said there was no doubt that Mr. Waddell, according to the figures he had given them, had attained excellent results, as far as the quantity of gas produced per ton of coal was concerned; but he (Mr. Whimster) could not understand the enormous quantity of coke the author used.

Mr. WADDELL said it was absolutely necessary that the gases should become well mixed; and one of the advantages claimed for the use of the furnace in question was that this was effected. Again, it was most desirable that the mixing should not take place at one point, but all the way round.

Mr. WHIMSTER remarked that this was exactly what could not be done. The gases could not be made to mix all the way round. It would take place the moment they met.

Mr. WADDELL said he was pleased to have had his paper criticized; and he would try to benefit by the criticisms. There were, of course, many things which they would like to be able to do, but they could not succeed; and the only object he had in writing his paper was to give the members of the Association the benefit of the experience he had gained in the use of Mr. Hislop's furnace. With reference to the Honorary Secretary's statement that the percentage of coke used was very high, he (Mr. Waddell) admitted that this was so, but it was part and parcel of his experience; and this being the case, he felt he ought to mention it.

Mr. W. S. STORMONTH (Coleraine) remarked that Mr. Waddell had given the members some very valuable information in the course of his paper.

Mr. J. ROBB (Limavady) then read the following paper :—

RETORT-SETTING FOR SMALL GAS-WORKS.

In attempting to lay before you a short account of a system of retort-setting adapted to meet the wants of a great many managers of small gas-works in Ireland, who, like myself, have to struggle against badly constructed works, small consumption during the summer, and very limited funds, I hope those who have more experience in these matters than I have, will deal leniently with any blunders I may make in the literary part of my work.

During the period I have lived in Ireland, I have been surprised at the yield of gas obtained per ton of coal in small works; some returns showing as little as 8000 cubic feet on the consumers' meters, while a great many average only 7000 to 8000 cubic feet on the station meters. Now, in looking for the cause of this, I find much of the evil is due to the want of summer consumption. The

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retorts are kept going all through the summer, and very often only charged once in two days. This style of working swallows up all the coke saved in winter; and then recourse must be had to coal. But why should this be so? Simply because if the heat on the retorts is once let down, it cannot be brought up again in anything less than a week or a fortnight. This may seem strange to some of you; but still it is a fact, and it is not to be wondered at, when we see the class of men who have hitherto had charge of these works. The salaries offered in some cases are not sufficient to procure proper food; and working as they do from six in the

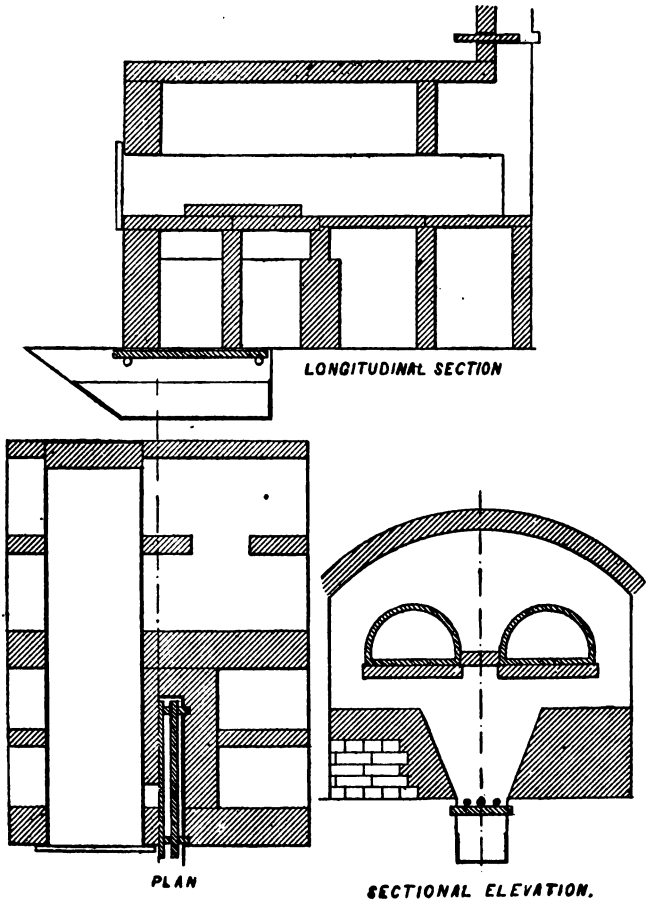

FIG. 14.—ROBB'S RETORT-SETTING FOR SMALL GAS-WORKS.

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morning until twelve and occasionally later at night, there is no time for thought, and no money to spare to acquire knowledge from the experiences of their more favoured brethren. At the same time a lot of useless, nominal officials, have been drawing salaries, sometimes twice and even three times as much as that of the manager. If these salaries were given to the manager, who, with a little labour assistance could do all the work, he, having a little time at his disposal, would be able to improve himself; and, with the aid of an Association like this, the small works in Ireland would soon bear comparison with those similarly circumstanced in England or in Scotland, and also prove more profitable for both producer and consumer.

Having to meet difficulties in carbonizing of the kind just described, I will simply relate how I got rid of them. When I took charge of the Limavady works about two years ago, out of nine retorts I had none that would work to my satisfaction. During good dry, mild weather, I could get a heat sufficient to yield 9000 cubic feet of gas per ton; but whenever cold wet weather set in, away went my heats, giving a correspondingly low return, of about 8000 cubic feet per ton, and requiring even then an expenditure of fuel equal to 90 per cent. of the coke made. In fact, it was the old story of the furnace white, and the retorts little more than red. The sudden drop in the temperature in wet weather was caused by the bench being built close up to a 14-inch outside wall, and the flues too small. To save the heat lost through the back wall at that time was impossible; but I determined to improve my retort-settings if possible. With a view to carrying out this purpose, I looked over all the styles of retort-settings I could think of, and consulted all the books and journals I could lay my hands on; but I could find very little that seemed just to suit my case. However, I got as much general information as led me to see that, through the smallness of my nostrils and flues, and the want of a proper mixing chamber for the gases, I was losing more than half the heating power of my fuel, as, instead of getting the theoretical 7000 units of heat due to the combustion of coke to carbonic acid, I was only getting in the oven the 2400 units due to its combustion to carbonic oxide. I therefore concluded that the oven ought to have a mixing chamber sufficiently large to allow the complete combustion to carbonic acid to take place before the gases circulated through the setting, and then have such an arrangement of flues as would utilize the gases as much as possible. My idea was to get the greatest heat at the front of the bed, and then by a zigzag course to extract the heat—the one chamber to act as an economizer to the other—and so keep up an equal heat along the retort. To find

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the capacity of my mixing chamber, I measured the air-spaces of my fire-bars. I have four air-spaces, each 21 inches long by 1 inch broad, which is exactly 84 square inches. The most economical velocity for gases is said to be 60 feet per minute; and my coke-space was 1 foot deep. I then calculated thus: Allowing, for practical purposes, an expansion of 1 cubic foot per degree Fahr. of heat generated for every 500 cubic feet of air entering the fire, and, as air absorbs heat very rapidly and just as rapidly gives it up, assuming that it attains a temperature of 500° Fahr. in its passage through the coke, and that the temperature on complete combustion to carbonic acid is 4500°; then 4500—500 = 4000 cubic feet due to expansion, *plus* the 500 cubic feet entering = 4500 cubic feet per 500 cubic feet, which is equal to 9 cubic feet per foot of air entering the furnace. But my air entrance was not 1 foot, but 84 square inches; and this, calculated to a velocity of 60 feet per minute, gives 3 cubic feet as the size of the mixing chamber (independent of the coke-bed), which will allow the complete change to carbonic acid to take place.

The next point to be considered was the circulation of the hot gases. To effect this economically, the flues must be neither too large nor too small; so by simply measuring their length and breadth, and distributing them into 3 cubic feet, and having no part contracted, except at the entrance into the main flue (and that only by the damper), I considered that the oven would be certain to heat up to about the full calculation, and if the flues were evenly divided, an equal heat would be obtained all through. To test this rule practically, I embraced an opportunity which presented itself. I had a double bed of iron retorts, which had not been in use for a number of years, owing to difficulties experienced in getting them to work. Last autumn I took them out, and, finding they were new, reset them in accordance with the principle I have just tried to explain; and, in order to meet the difficulty of the back wall, I built my flues vertically. I divided the oven into three compartments, the first division wall being placed immediately at the end of the furnace bars, and built up the coke bed to a thickness of 14 inches, the remainder 4½ inches, and the second wall 4½ inches all through. The retorts are set only 6 inches apart; and a tile covers this from the first division wall to about 6 inches of the front wall of the oven. The flame from the furnace travels under the bottoms of the retorts, up the sides of the first division, down the sides and under the bottom of the second division, on to the third division, which ascends the same as the first to the damper, which is on the top of the arch, where the waste gases escape into the main flue.

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I have now arrived at the most important point in my paper —viz., the practical results. This oven was started on Oct. 1, 1887, and a separate account of the working was kept until March 1, 1888. Owing to my storeage being very small, I had to damp down every Sunday, which was somewhat of a disadvantage. The retorts are Ω-shaped, 18 in. by 13 in. by 7 ft. 6 in. long; and the coal used was Arley Mine. There was no exhauster; and the back pressure was 6 inches. From date to date, they carbonized 130 tons of coal, giving 1,298,300 cubic feet of gas; being 9980 cubic feet per ton. The largest yield of gas obtained in 24 hours was on Dec. 18—being 13,900 cubic feet; and the average make was 6000 cubic feet per mouthpiece per 24 hours. They returned in coke 4700 bushels, out of which we sold 2300 bushels. This shows 50 per cent. of the coke made used as fuel; but the same furnace would have heated six retorts. Our revenue from this source was increased about 200 per cent. Another important matter is that the furnace heats up to carbonizing point in twelve hours, if standing over for a lengthened period; and if from Saturday evening till about ten o'clock on Sunday night, four hours will bring it up to carbonizing heat. There is no difficulty in getting up the heat; on the contrary, we had to use very great caution, and damp down for half an hour at the end of every three hours before charging. After all, one of the sides melted; but, thanks to the use of Sellars's cement, when it had been repaired it was as good as ever.

After seeing the success of this setting, I erected a single bed of retorts on the same principle, following the same rule, and was rewarded with like success. Of course, the saving in coke is not the same, as I have often to damp down for three and four days together; but what I save when working (which is about 15 per cent.) restarts the oven. I am erecting a bed of three fire-clay retorts on the same principle; so I shall learn the adaptibility of the rule to them also.

I hope this simple effort to help my brethren in small works will meet with their approval, and that we, in Ireland, may soon be able to stand comparison with similar works across the water. Seeing that the majority of the works in Ireland make from 1 to 3 million cubic feet of gas per annum, I hope it will also awaken a desire in all the members of this Association to aid them.

Discussion.

Mr. A. WADDELL (Newtownards) thought the Association were deeply indebted to Mr. Robb for his paper, which was upon a subject of very great importance to those who were connected with

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small gas-works. Mr. Robb had dealt with his subject in an able manner, and had made some very outspoken and appropriate remarks upon several points. There were some matters in the discussion of which a little plain speaking was necessary; and he thought Mr. Robb had complied with this requirement. He (Mr. Waddell) only regretted that there were not more like him.

Mr. A. GIBB (Newry) thought the plan adopted by Mr. Robb, of splaying out the sides of the furnace from the bottom to the top, must protect them from the fierce heat of the gases. He asked whether the round bar used in this setting was meant to get rid of the clinker more easily than with an ordinary bar.

Mr. ROBB replied that the men found it much easier to remove the clinker when the bars were round.

Mr. FEATHERSTONE said he used a jet of water, and he had little difficulty with clinkering.

Mr. ROSS stated that he kept plenty of water in the ash-pan, and he had no trouble with clinkering. He pointed out that there was nothing new in splaying a furnace.

Mr. R. MERRILEES (Castleblayney) said that he splayed the walls of his furnaces, and he found that they lasted much longer than they did when they were built square.

VOTES OF THANKS.

Mr. WADDELL proposed that the cordial and hearty thanks of the meeting be given to the President, for the ability with which he had presided over the proceedings.

Mr. GIBB seconded the proposition, and it was carried with applause.

A vote of thanks was also accorded to the Secretary and Treasurer, on the motion of Mr. GIBB, for the way in which he had discharged the duties of his position during the year.

The PRESIDENT thanked the proposer and seconder of the vote for the kind expressions they had made use of with regard to himself, and also the meeting for the equally kind manner in which they had received the vote, for which he was very much obliged to them.

The SECRETARY also desired to avail himself of the opportunity of thanking Mr. Gibb for his kind remarks with regard to himself, and the meeting for their vote of thanks.

The proceedings then terminated.

The members subsequently dined together at the Railway Hotel, under the presidency of Mr. Stears.

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MANCHESTER INSTITUTION.

QUARTERLY MEETING, AUG. 25.

This Meeting was held in the Town Hall, Doncaster, Mr. T. DUXBURY, of Darwen (the President), in the chair.

There was an average attendance of members, who were met at the railway station by Mr. Robert Bridge, the Engineer and Manager of the Doncaster Corporation Gas-Works, and conducted to the Elephant Hotel, where luncheon was served. Immediately this was over, an adjournment was made to the Council Chamber of the Town Hall, which was placed at the service of the Institution by the Mayor (Alderman Wainwright).

The PRESIDENT having taken the chair,

The HONORARY SECRETARY (Mr. Harrison Veevers, of Dukinfield) read the minutes of the previous meeting, held at Northwich in May (see *ante* p. 146); and they were passed as correct.

NEW MEMBERS.

Two new members were then elected—viz., Mr. Tom Settle, Manager of the Gas-Works, New Mill, near Huddersfield, who was nominated by Mr. J. Booth (Southport), and seconded by Mr. W. W. Hutchinson (Barnsley); and Mr. W. Drewry, Manager of the Gas-Works, Cleethorpes, who was proposed by Mr. T. Newbigging (Manchester), and seconded by Mr. Harrison Veevers.

ORDER OF BUSINESS.

Some discussion followed as to the wisdom of making a departure from the printed programme. According to this, Mr. Newbigging was down to read a paper on "Gasholders without Upper Guide-Framing," which in its turn was to be followed by the long-postponed discussion on Mr. J. Dalgliesh's paper on "Oil and other Illuminants, and their Effect on the Consumption of Gas," read at the meeting of the Institution in Manchester in December, 1887.* On a vote being taken, it was shown that the general opinion was largely in favour of keeping to the programme.

* See "Reports of Gas Associations" for 1887, p. 316.

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Mr. NEWBIGGING then proceeded to read his paper, as follows :—

GASHOLDERS WITHOUT UPPER GUIDE-FRAMING.

A valuable paper on "The Guide-Framing of Gasholders" was read by Mr. W. H. Y. Webber, of London, at the meeting of The Gas Institute held in Glasgow in 1887.*

In treating of the subject, the author did not advocate or suggest any new principle of guiding the structures in question, but contented himself with endeavouring to show that, by a modification of the ordinary arrangement of bottom rollers (which he proposed to duplicate and strengthen, to bear the extra strain which would be thrown upon them), and by the addition of tangential rollers, the upper guide-framing, or the greater portion of it, might be dispensed with. The present paper is intended to describe a recent invention of Mr. William Gadd, of Manchester, whereby an entirely new principle is introduced, by the application of which a gasholder may be securely guided from the bottom curb; the whole of the elevated framing being done away with, whilst at the same time the strain of wind or snow pressure upon the holder has the effect of producing greater rigidity in the structure.

The weight of the guide-framing of gasholders, as usually designed and constructed, if composed of wrought-iron standards, slightly exceeds that of the floating vessel; and if of cast-iron columns, the weight of the framing is greater still. It follows, therefore, that the cost of the guide-framing of a holder amounts to about one-half the cost of the complete structure.

I have various recent examples of gasholders and their guide-framing, which I have put together in the form of a table, which may be quoted in support of this position.

Description.	Weight of Holder or Bell.	Weight of Tank Guide-Framing.	Weight of Upper Guide-Framing.	Total.
	Tons.	Tons.	Tons.	Tons.
Single-lift holder, 50 feet dia., 16 feet high. . .	18	3	17	38
Do., 72 ft. dia., 18 ft. high	44	5	40	89
Do., 80 ft. dia., 20 ft. high	47	5	50	102
Do., 80 ft. dia., 28 ft. high	49	9	53	111
Two-lift telescopic holder, 80 feet dia., each lift 20 feet high	70	6	82	158
Do., 80 feet dia., each lift 20 feet high	61	7	70	138
Single-lift holder, 100 feet dia., 24 feet high. . .	66	7	75	148
Two-lift telescopic holder, 120 feet dia., each lift 24 feet high	107	12	86	205

* See *Journal of Gas Lighting*, Vol. L., p. 171.

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Now, such being the facts, it is evident that if the upper guide-framing of a gasholder could be dispensed with altogether, and equal or greater stability and safety in the rise and fall of the floating vessel secured, a saving of about 50 per cent. would be effected in the cost of construction and erection. An attempt—and, as I believe, a successful attempt—to secure this condition of safety, whilst dispensing with the elevated framing of gasholders, has been made in Mr. Gadd's invention—two models of which I have the pleasure to submit. Like most important inventions, the means for attaining the end contemplated are as simple as they are effective and beautiful. So simple are they, indeed, that the excellence of the invention will be obvious at a glance; and the first thought that strikes us on examining the models is one of wonder that the expedient has never been thought of before.

Briefly stated, the invention for dispensing with the elevated guide-framing consists in placing the channel or other guides within the tank at an angle, like the thread of a screw, instead of in the vertical plane, as has hitherto been the invariable practice. The guide-rollers attached to the bottom curb of the holder are ranged either radially or tangentially with the sides of the vessel; and as they work in the channel or rail guides provided for them, a helical or screw-like motion is communicated to the floating vessel as it rises and descends in the tank. The arrangement is shown in the accompanying figure.

The guides attached to the tank sides may be placed at any angle from 45° upwards. In the models before you they are fixed, one at an angle of 45°, and the other at 60°, which latter is probably the most suitable for single-lift holders. The effect of thus arranging the guides is obvious. So long as the rollers are free to move within the guides, it is impossible that the holder can tilt so as to get out of the vertical; the tendency of wind or other pressure exerted against the sides or on the roof of the vessel being to produce what may be described (imperfectly, however) as a locking action, which will sustain the holder in the upright position, however great the strain, within the resisting strength of the rollers and their carriages. Whilst this locking or gripping action gives rigidity to the vessel, enabling it to resist the overturning force, the rollers are perfectly free to rise and descend within the guides.

Adopting Mr. Webber's description—and I see no reason to question its accuracy—that the gasholder, as at present constructed, may be compared to a pole whose lower end is placed in a socket, *though not resting on a base*, it may be pointed out that it is just the absence of this bottom bearing which accounts for the inherent weakness of such structures. It will be seen, however,

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that the holder, as now proposed to be guided, has almost as positive and substantial a bearing as it would have if lifted bodily out of the tank and placed upright on the ground. It is in this that the chief value of the invention consists; for at the present time the tank-guides, owing to their vertical direction, afford no actual security against tilting—their only office being to prevent the swaying of the vessel to and fro when under stress of outside pressure.

It is evident, further—and this is a most important consideration—that immediately the strain comes upon any part of the holder under the new conditions of guidance, the resisting action of the whole of the guides, both front, back, and sides, is brought into operation, one-half the rollers being in tension and the other half in compression; and the vessel is literally held with (to use a paradoxical expression) a grip rigid yet loose.

It will be seen, therefore, that by the proposed new method of construction, the guides within or upon which the bottom rollers work, answer not merely the purpose of guiding the vessel in its rise and fall, but also serve as cramps or grips, withstanding, by their locking power, whatever strain may be exerted against the

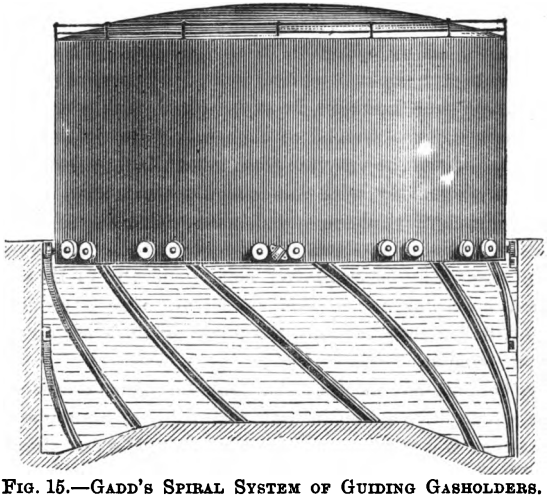

FIG. 15.—GADD'S SPIRAL SYSTEM OF GUIDING GASHOLDERS.

holder, whether laterally on the sides, or perpendicularly upon the roof. As a matter of fact, the effective capability to resist strain—assuming that the floating vessel and its trussing are sufficiently strong—is only limited by the strength respectively of the guides and that of the carriages and rollers.

It may be suggested that a holder thus guided and kept in the upright position solely from the base, will need to be strengthened

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in the upper curb, so as to overcome the crushing force exerted by wind on the sides. A moment's consideration, however, will show that this is not necessary. As at present constructed and guided, gasholders are capable of resisting the maximum crushing strain that is exerted by the greatest wind pressure upon their exposed side—*i.e.*, a pressure equal to 20 lbs. to the square foot exerted upon a plane represented by 50 per cent. of the area of vertical transverse section of the holder. The elevated framing does not relieve the crushing strain in any degree; on the contrary, it assists or aggravates it by presenting a rigid support to the leeward side of the vessel. I should scarcely have mentioned this, had it not been urged as an objection.

The only possible danger that can arise is that of distortion or dislocation; and this can readily be obviated by giving the vertical supports or stays inside the holder more of the form of a girder than at present. Probably the triangular form, with the base of the triangle at or near to the bottom curb of the holder, would be the best. These would receive the strains exerted against the sides and roof of the vessel, and transmit them to the bottom curb and rollers, and thus secure the stability of the whole. It will be urged as an objection to this that the effect will be to add weight to the holder which was previously in the guide-framing. Any such addition, however, if required, will be trifling as compared with the weight of the guide-framing as at present constructed, and will be very far from neutralizing the economical advantage of dispensing with this framing altogether.

With the exception above noted, there need be no change in the mode or materials of gasholder construction. It is not unlikely that steel may be employed more generally in these structures than heretofore; and this, whilst allowing a reduction in the weight, will greatly increase the power of the trussing to resist strain from outside.

It may be pointed out that the probable cause of most of the accidents which have arisen in the overturning of gasholders under wind pressure was owing to the want of rigidity in the bottom carriages and rollers, allowing of the swaying to and fro of the floating vessel, thus causing sudden impact against the vertical columns, which have been snapped off by the blow; and the holder, being guided at neither top nor bottom, has been overturned by the wind. It is one of the chief merits of the present invention that rigidity of the rollers is secured as a natural consequence of the method of arrangement of the guides; and is not dependent on either the skill or the attention of the workmen employed in construction and erection.

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The ordinary method of counterbalancing gasholders, where counterbalancing is required (as in the case of holders whose diameter is small when compared with their depth), will not be necessary under the proposed system; for the same result will be obtained by increasing the length of the roller path, by placing the guide-rails in the tank at a less angle.

Perhaps it will be suggested that, with the tank-guides constructed and fixed as described, there will be difficulty experienced in raising the holder for repair when the water is out of the tank. This objection has no force. All that is required under the new conditions is to arrange the lifting screws and chains so that the pull will be in a slanting direction, when the vessel will be raised with as much ease as at present.

Exception may be taken to the invention from an æsthetical point of view. It may be urged, with some show of reason, that the only possible ornamentation in connection with a gasholder is supplied by the elevated guide-framing, and that wanting this the floating vessel standing above ground without apparent support will be a somewhat ungainly object. True, the holder might be ornamented round the top ring with palisade or open chequer-work; and other methods of ornamentation may be adopted. Whether this be so or not, however, appearance will not weigh for one moment with those who are concerned in providing the capital required to be expended on such structures; and neither ought it to do so, when the advantage in the saving of cost is so manifestly in favour of the proposed method of construction. This saving is not confined to the ironwork of the holder, but extends also to the underground tank. The necessity for the provision of piers or counterforts, and large and expensive foundation-stones for the bases of columns or standards, will disappear; the tank for such a holder being cylindrical both inside and outside the walls, from base to summit. Again, in the case of holders made for shipment abroad, there will also be the saving of about 50 per cent. effected in the cost of freight. In these days of active rivalry in the methods of artificial illumination, whatever improvements tend to keep down the capital of a gas-works will be welcomed.

At the close of the paper, Mr. Gadd proceeded to illustrate by means of models—one of a single-lift, and the other of a three-lift holder—the action of the invention. In the single-lift holder the guides were placed at an angle of only 60°.

A conversational discussion followed.

Mr. NEWBIGGING remarked that the invention was so simple that anybody could understand it. There had been a good deal of difficulty in preparing a model of a three-lift telescopic holder, because

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the cups between each lift could not be made the necessary depth to stand the pressure; so they had had to overcome the difficulty as best they could.

As a test, weights equal to four times the weight of the bell were placed on the one side of the single-lift holder.

Mr. W. CARR (Halifax) pointed out that, under this test, the holder went down with a jerky motion, instead of steadily.

Mr. GADD explained that the model was roughly made, and that this partly accounted for the want of steadiness; while a little water which had found its way into the pipe was also against the success of the experiment. The weights were afterwards distributed, so as to more adequately represent the pressure which would be exerted by snow; and the jerking was then less perceptible.

Mr. W. W. HUTCHINSON (Barnsley) suggested that when the gas-holder was very nearly full, it would be unstable, and might easily be blown over.

Mr. GADD contended that the holder was always in a condition of stability, unless, as was improbable, the wind lifted it bodily out of the tank.

Mr. D. CLARKE (Ashton-under-Lyne) thought that the plates and rollers would have to be stronger than in a holder of the ordinary kind.

Mr. GADD admitted that the details of the structure certainly might require a little modification.

Mr. NEWBIGGING said he thought the vertical support ought to be stronger, and that it should take the shape of a girder of triangular form. In connection with the model of the telescopic holder, he explained that two of the series of guide-rails had been placed one way, and (unintentionally) the third the opposite way; the result being that, after turning in one direction, while the two upper lifts were being raised, the holder turned in the contrary direction during the filling of the third lift. Referring to the pressure exerted with a view to overturn the model, he said that in so small a model a very little push with the hand represented an abnormal wind pressure; but, to his mind, a holder on this principle would be perfectly rigid under even an extraordinary pressure, owing to the locking action of the rails and rollers.

Mr. ISAAC CARR (Widnes) asked if the suggested triangular girder would be from the top to the bottom of each lift.

Mr. NEWBIGGING said it would not, only in the inner lift. His idea was that, if more strength was needed, it should take the form of a girder.

Mr. I. CARR maintained that it would not strengthen the structure, because the whole strain would come against the bottom sheet.

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Mr. NEWBIGGING pointed out that in the outer lift of a telescopic holder, the additional strength, if any were required, would be furnished by the guide-rails.

Mr. GADD added that the question of strengthening the holder internally was a matter for experiment, and one in which they would be guided by experience.

Mr. NEWBIGGING said the inherent weakness of the ordinary gasholder consisted in the want of a positive bottom bearing; and they had this in the present invention.

Mr. GADD pointed out that the pressure was centred on one point at the top; the roller at the bottom was one leg of the lever at which the pressure was being exerted. The roller on the opposite side was resisting that pressure; and this leg of the lever was twice as long as the other. The power was diminished by having a short lever actuating; and the force was always exerted downwards to the rollers. The only thing he could possibly conceive as tending to danger was that, if there was a hurricane sufficiently strong, the plates might be stripped away; but in this respect there would be no difference between his arrangement and an ordinary holder.

Mr. I. CARR considered that very great care would require to be taken in getting the guides an equal distance apart.

Mr. GADD said he was glad that matter had been noticed. It was a point which had occupied a great deal of his attention in working the question out. Although it was highly desirable that something like accuracy should be exercised, still he had, apart from that, made provision for any slight inequalities. This provision was in moveable centres to the rollers or slides; and this would allow for slight inequalities. He had made experiments with a number of rollers arranged in a plane; and where they had been fixed at slightly diverging angles even, he had been able to keep the apparatus square and run it up and down.

Mr. HUTCHINSON asked what would be the effect of a small stone or piece of wood getting into the grooves? It might be possible, he feared, for two or three small stones to do a great deal of mischief.

Mr. GADD said it would be difficult, if not impossible, to lodge stones in a groove the angle of which was 45°; and wood would simply rise to the surface of the water.

The PRESIDENT said the principle of constructing a gasholder explained by Mr. Newbigging was so novel and so contrary to the received notions of what is and ought to be done, that they could not attempt to discuss the paper adequately that day. They had better, therefore, defer the discussion until the next meeting;

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before which the members could read the paper and consider the matter carefully. But as they had Mr. Gadd present, he should have pleasure in hearing anything he might wish to say; and advantage might also be taken of the opportunity to put to him any questions which they might wish to ask.

Mr. W. CARR said he should like to make a remark or two, and put some questions; and it would perhaps facilitate Mr. Gadd's reply if he did it in a formal way, because it was confusing to any-one to have questions put from three or four sides of the table at once, and to be expected to answer them all satisfactorily. Like every other member of the Institution, he came there quite at sea as to what kind of principle they were going to have explained; and he was both surprised and pleased at the plan submitted to them by Mr. Newbigging. At the same time there were one or two points—he did not know whether or not they would be looked upon as objections—that he wished to draw attention to. Of course, it was very easy for them to sit there and say: "It is a very good thing, and we like it;" but the point was this—Would they adopt this plan when they came to put up a new gasholder? Personally, he should not like to say that he thoroughly agreed with anything he saw there, unless he felt so much in accord with it as to recommend its adoption at his own works. One of the most important objections which occurred to him was this—that when the first lift was filled, and the second half filled, the rollers would be midway up the third lift; so that if any wind pressure then came, the whole of the strain would be upon the guides supporting the sheets of the third lift. The locking power was perfectly easy to understand when the idea of the screw motion was grasped, because any vertical or horizontal pressure would be resisted by the whole screw when once it was fairly in the thread. So it would be in this case. But the strain must be taken somewhere; and it would have to be taken by the guides and the sheets midway between the coping and the bottom of the third lift, which he took to be the weakest point. He thought the chances were that distortion would be caused if the pressure were very great at any particular point of the holder, because there was nothing to take it but the guides or the sheeting. If this happened, distortion might take place, with the effect, he was afraid, of upsetting the gasholder. To his mind, this was the weakest part of the construction. In the single-lift holder this objection would not obtain at all, as the guides had a perfectly rigid backing from top to bottom; and the pressure might come at any point from top to bottom, and had a perfectly rigid system to transfer itself to. But it was not so when one lift was working

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inside another, especially at the point when one lift was getting half way up, and having nothing but the sheeting to resist it. He mentioned this because Mr. Newbigging had said in his paper that no additional weight would be required. Consequently, if there was no extra weight, they would have only the ordinary thickness of sheeting, and nothing else, to resist the strain. Another point he should inquire into would be that of the rollers. The rollers would have to be in working order; and Mr. Gadd had only complicated matters by saying he would have some with a horizontal sliding motion. In an ordinary way, a certain amount of deposit took place on the rollers; and the time came when the rollers did not revolve. In vertical slides this did not matter very much, if the slide was true, and the roller a good fit. It simply went up and down, and formed a rigid face; and he believed that in nine out of every ten slides the rollers simply formed a bearing, which slid up and down the guide-rails in the tank. This was a consideration which would have to be carefully taken into account by anyone adopting this plan. There was a third point. Mr. Newbigging said that the ordinary method of counterbalancing small holders would be dispensed with by increasing the length of the roller-path, which could be done by placing the guide-rails in the tank at a less angle. He (Mr. Carr) did not understand how that would dispense with the counterbalance. He believed even with a single-lift holder much greater strength would be required in the lower curb, because if the strain was to be received by the lower curb, a much stronger curb would be required than now. As a rule, the bottom curb was made too weak; and it would be necessary that it should be strong in this case. These were a few points which occurred to his mind; and they were questions which would have to be answered before anyone could put any of these holders to work. If they could be satisfactorily answered, he did not see why they should not adopt the plan, and dispense with guide-framing. There seemed to be a great deal in it; and if they could save 50 per cent. of the cost, he did not think they would be justified in going on as now.

Mr. C. E. Jones (Chesterfield) asked of what material it was proposed to make the rollers and the internal guide-framing? This was not stated in the paper; and it would be well to know it. He should also like to ask whether any time had been really taken up in testing the machine, which was of a very novel, daring character, and conferred upon the author a considerable amount of praise for his ingenuity and boldness in departing from the old lines. Had any experiments been made with different waters, and their action upon the rollers and the guide-framing? It appeared to him that if

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they used cast iron, they would have to fill the tanks with distilled water, because with some water the grooves and guides would certainly in time become filled with corrosion, which would largely increase the friction, and throw more strain upon the sheeting. The weak place in the holder when above ground would be towards the bottom plate—the point of greatest leverage; and this would have to be very materially strengthened, which would add largely to the weight of the structure. It was a most extraordinary invention, and very beautiful in its action, as worked before them. The idea of making a gasholder into a screw, and guiding it from the bottom roller, entitled the author to their highest admiration; and the excellent manner in which Mr. Newbigging had put it before them deserved their thanks.

Mr. GADD, in reply, said he had not made any experiments with materials or water; for the simple reason that the rollers and other parts of the structure were placed in similar positions to those they occupied in ordinary gasholders. If water would destroy the new rollers, it would destroy the old ones. He could not see where any new principle came in as to this. The rollers and guides upon his system would not last for ever, any more than they would on the old plan. No doubt a certain amount of corrosion would take place; but he failed to see that there was any difference in the conditions, with regard to the water attacking the details of the structure, between this and the details of construction of ordinary gasholders. Mr. Carr had very properly brought forward several questions which, he said, required to be answered. They ought to be answered; and he (Mr. Gadd) would try to answer them. He would first of all take the last objection which Mr. Carr made—namely, that the rollers would set fast, and cease to revolve. Perhaps this would be so; but the fact was that he only put in the rollers in deference to received opinion. For his own part, he should prefer to make the guides without rollers at all. The single-lift model had been worked without any rollers at all—simply with solid sliding-pieces (solid pieces of metal cut at an angle). It required nothing more; and if he were a practical gasholder constructor, erecting a holder on his plan, he would advise that anything like revolving rollers should be dispensed with, because he could understand that rollers immersed in water which contained material tending to disintegration, would set fast. Rollers were put on the model, and in the diagram, simply in deference to present ideas as to the mode of construction. Another important consideration to which Mr. Carr had referred was that of the position of the second lift. There was no doubt that when the holder was in the position described by Mr. Carr, it would be in its

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most vulnerable condition; but he should certainly think that, with proper construction, it would be sufficiently strong for any possible purpose, and would resist any pressure that could be brought against it. In the first place, he should never expect or dream of putting pressure upon the sheeting; he should not think of doing so in an ordinary gasholder. The pressure must be taken up by the framing of the holder. He took an ordinary holder to be something like an umbrella. There were the ribs; and there was also the canvas which covered it. The sheeting was only like the canvas of the umbrella; and it was in the mechanical construction of the frame which carried the sheeting that strength was obtained for resisting the strain. Consequently there should be a frame—a rigid frame—underneath the sheeting of each of the lifts. This frame was provided by the angular guides; though these, of course, could be strengthened, because it was not necessary to have rollers to each of them. Each was attached to a fairly rigid ring top and bottom; and there should be a fairly rigid frame. The sheeting was only to keep in the gas. This was his idea, from the engineering point of view; and to his mind it was very simple. If the present mode of putting sheets on was not suitable to this plan, it must be abandoned; because there was no reason why every present idea should be slavishly followed, and Mr. Carr, with his ingenuity, would not be slow to adopt some new method to suit the new ideas. He was glad that Mr. Carr put his finger upon this objection; because it was very desirable that the thing should be tested at this and every point. What he (Mr. Gadd) wished to point out was that this was a weakness of a constructive character, which any constructive engineer would find means to overcome. It was not necessary to increase the weight; because, as they knew, weight could be added without increasing strength. It was a question of form, and of so constructing the holder as to meet the strain which would come upon it. Gas engineers were quite able to meet all these cases. The question to ask with regard to this proposal was, Was it progress? If it was progress—if it simplified the matter, and made it cheaper, then it was natural they should desire to follow it. As to the æsthetic question to which Mr. Newbigging had referred, this occurred to him at the beginning, but afterwards the simplicity of the structure without framing commended itself to him. After all, a simple structure was a grand thing; and a three-lift gasholder on his plan would have something of the simplicity of the pyramids of Egypt. (Laughter.) He was not at all sure that there was not something æsthetic about it after all. At all events, if there was the element of cheapness, the æstheticism might have to

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go to the wall. With reference to the counterbalance, what Mr. Newbigging meant was this: That, if they had a flat angle of an inclined plane, there was more of the weight of the holder on the rails, and less on the gas. [Mr. Carr dissented.] Mr. Carr shook his head; but the proposition was capable of demonstration. The steeper the angle, the less of the weight of the holder would be taken off the gas; the flatter the angle, the more of the weight of the holder would be sustained by the rails and taken off the gas. In taking a wheelbarrow up a plank, the steeper the incline the greater would be the power required to be exercised at any given time. The flatter the angle and the larger the path, the less force would have to be exerted.

Mr. NEWBIGGING remarked that, in resisting a strain, this method of guiding a holder had many advantages over the old system; because, as he had already mentioned, whenever any force was exerted, the whole of the guide-framing came into action, back and front and sides—one-half of the rollers being in tension and the other half in compression.

Mr. GADD said that Mr. Carr thought the rigidity of the bottom curb would want to be much increased. If they would consider the thing in reverse—that was to say, if the flanges of the rollers or solid sliding-pieces were put outside instead of inside, they would place the ring, instead of in compression on the strain, in tension. So they could practically work with a very flexible ring indeed. What he meant was that if the flange were put on the outside of the rollers of the outside lift, instead of inside, any pressure at the top would cause the stud to pull at the roller and the roller flange, so that the strain would be put upon the rollers in tension, tending to pull them away from the tank instead of pressing them in. As it was now, there was a compression both of the roller towards the tank and of the ring itself. If necessary, both methods could be adopted; and they could have two grooved rollers with a flange between. He did not, therefore, think it really necessary that the bottom curb should be strengthened to any material extent; but if it were, it seemed a comparatively small matter as against the great gain of taking away the guide-framing.

The PRESIDENT said nothing but benefit could follow from the conversational manner in which they had discussed the matter; but the formal discussion would be postponed till the next meeting.

Mr. W. CARR then rose and said he had considerable pleasure in moving that their thanks be given to Mr. Newbigging for his paper. He had done them very great honour indeed in submitting it first to the Institution. It showed the warm interest which he

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took in the Institution, and the good feeling he had towards it, that he should honour them by bringing the idea before them, before submitting it through another source. As to the æsthetic question, to which reference had been made, he thought this might be left out of consideration. People already talked of a thing being "as ugly as a gasometer;" and their views were not likely to be altered. As to the question of counterbalancing, both Mr. Gadd and Mr. Newbigging were at fault; and he thought it would appear plain to them when they came to think of it.

Mr. W. W. HUTCHINSON seconded the motion. He agreed with Mr. Carr that great honour was done them by Mr. Newbigging putting this matter before them at a time when it was one of the great questions of the day. While he thought the gas profession had somewhat redeemed the name it had for the ugliness of its gasholders, and had of late years made them more presentable, they were likely to revert to the simple grandeur of the pyramids. In considering this invention, they would have to think of their neighbours. They could not disregard what might, to uninformed minds, appear to be the dangerous nature of the structure.

The PRESIDENT said he had great pleasure in putting the motion. Mr. Newbigging, he considered, was entitled to their best thanks.

The resolution was unanimously carried.

Mr. NEWBIGGING, in responding, thanked the members for their hearty and unanimous vote, and said he had been much struck with this invention, and very willingly undertook the duty of writing a paper upon it. He wrote it without communicating with Mr. Gadd; but when he came to consider the matter of the counterbalancing, he could not make up his mind upon the question whether they could dispense with the counterbalance weights by placing the guides at various angles. Accordingly, he called on Mr. Gadd, and discussed the question with him at length—he (Mr. Newbigging) taking the view held by Mr. Carr, and Mr. Gadd successfully combating his arguments.

MR. DALGLIESH'S SUPPLEMENTARY PAPER.

As it was now within about a quarter of an hour of the time for adjournment, the discussion of Mr. Dalgliesh's paper was again postponed. Earlier in the day the President explained that Mr. Dalgliesh was unable to be present, but had sent an addition to his paper, which he wished to have read. It was as follows:—

OIL AND OTHER ILLUMINANTS, AND THEIR EFFECT ON THE CONSUMPTION OF GAS.

When reading my paper on this subject at our last December meeting in Manchester, I endeavoured to give the origin of various

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illuminants connected with artificial lighting—viz., from pine, resinous bark of trees, oily kernel of a nut, fat of animals, and the bitumen and naphthas of the mineral kingdom, in conjunction with a porous material provided to be dipped in these luminous combustibles; eventually leading to the invention of the torch, the candle, and the lamp. I also referred to the introduction of our illustrious illuminator of the world—gas; the production and distribution of petroleum oil (its commercial and financial position); and the use of electric light—but as an opponent, gave it as my opinion that oil was the most formidable, owing to its bountiful supply and the means of obtaining it.

I now wish to state a few facts connected with its use; and leave them to tell their own sad tale. A pamphlet circulated by the Hospital Sunday Fund, in June, 1886—entitled, "Within the Hospital Walls"—stated that the House Governor of a London Hospital said: "Every week we have to admit several people suffering from burns caused by explosions of paraffin-lamps; and nearly every week an inquest is held in London on somebody killed by them." Mr. Charles Marvin, who has written largely on the use of petroleum as an illuminant, says "that it is notorious that in every country the increase in the use of petroleum has been accompanied by an increase of accidents; and it was not surprising that I should feel saddened, that, in promoting a larger use of petroleum by my writings, I had at the same time multiplied death and disaster!" About the spring of the year named —on the steamer *Vaira* on the Volga—a paraffin-lamp accident caused the loss of more than 100 human beings. The baths at Scheveningen were burnt down through a paraffin-lamp; and Hampton Court narrowly escaped a similar fate. Captain Shaw, of the London Fire Brigade, says that 10 per cent. of the fires are caused by the paraffin-lamp. On Oct. 18, 1871, a cow accidentally kicked over a paraffin-lamp in a wooden shippon, setting the structure on fire; and the wind speedily carried the flames to an adjoining timber-yard on the banks of the Chicago River. From thence they spread through the whole city, destroying 20,000 buildings, and making 100,000 persons homeless. About 250 persons perished in the flames; and it cost Chicago a sum of nearly £60,000,000.

Throughout the United Kingdom, most distressing accidents and deaths are almost daily recorded in many of our valuable journals; and yet the consumption of paraffin and petroleum oils continues to increase. True, in numerous houses, where the poor of our large towns and cities dwell, there is no provision made by the landlords for the use of gas. There are hundreds, and

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in some towns thousands of houses where there are no gas-fittings, and the tenants are of such a character that it would be unwise to trust them with a quarter's gas supply; and these go to increase the percentage not using gas. Most of this class used to burn candles, and no doubt have recently substituted petroleum oil as their illuminant. If it had been possible for the engineers and managers of the various gas companies and corporations to have furnished me with the actual number of houses not fitted up for the consumption of gas, and the number with defective fittings, they would have shown gas in a more correct light. In my own district, hundreds of houses are without gas-fittings, and hundreds so wretchedly "hung"—not fitted—with ½-inch gas-pipes, and the rest to match, that tenants cannot use them. I do not think there is a district in the United Kingdom with such bad internal fittings—apologies for fittings; and when before the Committees of the House of Commons and the House of Lords in 1879, seeking for additional capital, &c., the writer exhibited numerous curiosities called gas-fittings, which greatly astonished even the opponents of the Bill.

In the towns shown in the table given with my former paper, where the consumption of gas is from 2,000,000 to 6,000,000 cubic feet per mile of main, there should not be much difficulty to cope with oil or the electric light; and the engineer must be a happy man. But where the consumption is only ¾ to 1 million cubic feet per mile, with 50 to 60 miles of mains and a hilly district, it is a difficult task, particularly when he has always to provide maximum dividends, good gas, &c.—all has to be good, but the manager's salary.

Notwithstanding our numerous difficulties, and the evil times, it is our duty to advance the interests of our shareholders or the ratepayers, as the case may be, and still exclaim: "Heave awa', lads, we're not dead yet." Let us hope that good may come out of evil.

Votes of Thanks, Etc.

The President moved a vote of thanks to Mr. Alderman Wainwright for his kindness in placing the Council Chamber at their disposal for the meeting.

Mr. C. E. Jones (Chesterfield) seconded the resolution, and it was adopted.

This concluded the formal business.

After the meeting, the members and a considerable number of friends proceeded in conveyances (which were in waiting) to view the ruins of Conisbro' Castle, an interesting ruin, situated about

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five miles from the town, associated with the early history of the country and with romance in the pages of Sir Walter Scott's "Ivanhoe." Time, however, did not permit of an extended stay. Immediately on their return, the members assembled at tea. After tea, a few complimentary toasts were proposed. One of these was that of "Kindred Institutions," in connection with which the new North of Ireland Association of Gas Managers was especially mentioned, with good wishes for its future success. A special vote of thanks was accorded to Mr. R. Bridge, the Gas Engineer of the Doncaster Corporation, for his courteous reception of the members, and the trouble he had taken, in conjunction with the Committee of the Association, to render the meeting, as it was, a pronounced success.

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SOUTH-WEST OF ENGLAND ASSOCIATION.

HALF-YEARLY MEETING, SEPT. 11.

This Meeting was held at Weston-super-Mare; and was attended by a large number of members and visitors. After a visit to the gas-works, under the guidance of Mr. J. H. Gray, Manager to the Weston-super-Mare Gas Company, the usual business meeting was held at the Queen's Hotel—Mr. H. Sainsbury, of Trowbridge (the President), in the chair.

Mr. Gray having briefly welcomed the Association to Weston, on behalf of his Directors.

The Honorary Secretary and Treasurer (Mr. Norton H. Humphrys, Assoc.M.Inst.C.E., of Salisbury) read the notice convening the meeting; and the minutes of the last meeting were taken as read. He also presented the statement of accounts for the year ending Aug. 31; and it was adopted.

New Members.

The President announced that the following list of applications for membership had been approved by the Committee, and he proposed its adoption:—Mr. S. Bark, Godalming; Mr. W. C. Bennett, Tiverton; Mr. C. V. Bennett, Wells; Mr. C. W. Folkard, Bournemouth; Mr. J. Griffin, Fareham; Mr. E. C. Riley, Great Western Railway Gas-Works, Swindon; Mr. H. F. Vincent, Frome.

Mr. T. W. R. White (Sherborne) seconded the proposition, and it was unanimously carried.

Office Bearers for 1888-9.

The election of officers for the ensuing year was then proceeded with. Mr. Ashton and Mr. Lowe volunteered to act as Scrutineers; and announced the result of the voting to be as follows:—

President.—Mr. J. H. Cornish, of Bridgwater.

Vice-President.—Mr. H. G. Crowe, of Wellington.

Members of Committee.—Mr. R. Beynon, of Torquay; and Mr. J. H. Lyon, of Cosham.

Auditor.—Mr. J. Nicholls, of Crewkerne.

Hon. Secretary and Treasurer.—Mr. N. H. Humphrys.

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Messrs. CORNISH and CROWE thanked the members for the honour they had conferred upon them.

PLACE OF NEXT MEETING.

The PRESIDENT having invited suggestions as to the place of next meeting,

Mr. CORNISH said that, as the members had placed him in the position of President, he hoped the Association would honour Bridgwater with its presence at the next meeting.

This was agreed to.

SUBJECTS FOR DISCUSSION.

The PRESIDENT next referred to the difficulty of obtaining papers for the meetings, and said it had been thought that any member might submit questions to be considered on the next occasion. Mr. Jervis had also suggested that the Committee should select subjects, and give notice of them to the members, so that each might prime himself to speak on one or more of them, or work up any experience that had fallen to his share. If followed out, this suggestion might perhaps save the work of writing papers, as, if everyone stated his experience, the whole of the time allotted for the meetings would be occupied, and a great deal of useful information afforded. He therefore invited suggestions or promises of papers for the next meeting.

Mr. J. J. JERVIS (New Swindon) subsequently named the following subjects as suitable for discussion at the next meeting:—(1) To what extent are the advantages claimed for separate sections of hydraulic main realized? (2) The testimony of users of anti-dip valves. (3) Scoop-charging. (4) Scurfing retorts. He undertook to collect some information on the first question himself.

The PRESIDENT then delivered a brief address, as follows:—

PRESIDENT'S ADDRESS.

Gentlemen,—It is to me a source of great satisfaction to find on the *agenda* paper of this meeting that "opening remarks" only are expected from the President, and not the formidable "inaugural address." In looking over the proceedings of our past meetings, I was also pleased to observe that the remarks made by former occupants of this chair had been brief, and purely introductory to the business of the meeting.

It is a pleasure to all who take an interest in these Associations to hear of their increasing number and rapid growth of membership; showing as it does the willingness of our brethren to work no longer in isolation and self-sufficiency, but to carry out the great and divine law of "bearing one another's burdens," and impart to others the wisdom which has been bestowed upon us. In the

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Journal of Gas Lighting for Aug. 21 last, I notice there is a report of the first annual meeting of the North of Ireland Association of Gas Managers; and in the succeeding number a paragraph announcing the proposed formation of a similar Association for the Eastern Counties of England. We wish these new Associations, as well as those of older growth, much success and increasing usefulness. We have had the pleasure of admitting to our ranks a larger number of new members this year than in any previous year since the formation of the Association; three having been admitted at the March meeting held at Trowbridge, and seven to-day. On reading the report of our first half-yearly meeting, held at Sherborne ten years ago, I find our number of members was then only 31. Now we stand at 74; or rather more than double the membership we had then. We are glad to know that death has not entered our ranks since we last met; but we have lost two valued members by removal to foreign parts. Mr. W. W. Monk, of Bournemouth, has gone to Melbourne, Australia; and Mr. Walter Thomas (who was with his father at West Cowes, Isle of Wight), to British Columbia. May they both prosper in their new undertakings. The latter gentleman has forwarded to our Honorary Secretary a few interesting particulars of his new surroundings, which will presently be read to the meeting.

A few months ago the theory of a new departure in the guide-framing of gasholders was ably discussed in the columns of our trade journals. The last few weeks have witnessed the successful, if only partial, accomplishment of this scheme. Mr. Livesey, with his accustomed energy and pluck, has made the experiment; and at the Rotherhithe station of the South Metropolitan Gas Company, a three-lift gasholder may be seen without the usual guide-framing beyond the second lift. May we not look upon this, and also the somewhat different plan invented by Mr. Gadd, and described by Mr. Newbigging in his paper read before the Manchester District Institution of Gas Engineers, as a type of what will in the future be the method of constructing and guiding our holders.

We have before us to-day three important subjects for consideration. Mr. Jervis has again kindly stepped forward to give us a few remarks upon "The Hydraulic Main, and Retort-Bench Bracing"—two points which have often tried the patience and ingenuity of many gas managers. Brickwork will expand with heat, and it is with difficulty that the hydraulic main, when placed on the beds, can be kept level, and so ensure an even dip in all the pipes; while the obstacles in the way of so bracing the retort-benches without exposing some portion of the tie-rods to a great heat are known to

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most of us. We hope Mr. Jervis will give us the true solution of this problem. Our old, but troublesome friend, naphthalene, will be alluded to by Mr. Davis, of Poole; and as he is going to tell us what he found to be a remedy for it, may all who are similarly perplexed try his plan, and obtain the same relief. Mr. Thomas, of West Cowes, has the happy knack of inventing new or improved appliances to meet the varying difficulties which are found in our works. A year or two since, he brought out a very capital "regulator" for tar-fires; while to-day he will describe "A Pressure-Gauge having no Joints." Many of the pressure-gauges at present made, when used with foul gas, often clog in the small passages with tarry matter. Mr. Thomas has doubtless experienced this obstruction; and has improved upon the gauges already in use to remove this and other defects. I feel assured that the foregoing subjects, together with the usual business of the Association, will occupy all the time at our disposal; but should the opportunity occur, we shall be glad to hear remarks on any other subject calculated to advance the interests of the Association; a free interchange of opinions being essential to our well-being.

We cannot assemble at these autumn meetings without looking forward with hope, yet anxiety, to the coming winter. In the spring we are full of plans for improving our apparatus during the summer; but in the autumn these are largely completed, and waiting for the test of increased make and increased consumption. All are hoping to sell more gas, and to manufacture, if possible, at a less cost. Trade seems to be somewhat improving throughout the country; and, if this is so, we trust it will mean a larger consumption of gas. Residuals, too, are looking up in every department; and we may hope to realize more from them than during the last winter. Some of you have ere this had your summer holiday, and are now braced up, and better fitted for the work lying before you. Others who have not will do well, if possible, to spend a few days in this popular watering-place of the west, and inhale the breezes from off the Atlantic Ocean. As the winter comes on, the conscientious gas manager has little time for recreation and change. All his powers of body and mind need to be concentrated on his work; for he must more or less unite in himself the various duties of engineer, chemist, and accountant, as well as take the general supervision of his workmen. Much wisdom and self-control are needed to carry on our different works successfully; and to those who, like myself, feel their insufficiency for these things, I would say in this, as well as in higher and more sacred matters, let us apply to the Fountain of all Wisdom, "who giveth to all men liberally and upbraideth not."

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Mr. J. J. JERVIS (New Swindon) next read a paper entitled

THE HYDRAULIC MAIN, AND RETORT-BENCH BRACING.

In the short paper I am about to read, I do not propose to enter into any matters relative to the sizes or shapes of the hydraulic main; or whether it should be of wrought or cast iron, or dispensed with altogether, and give place to a whole family of automatic valves, anti-dips, &c. I purpose only to speak of its position, or where it should be fixed by those who choose to retain it. Nearly all anti-dip disciples make use of the hydraulic; so that any discussion this question may raise will be of interest to them, and my sole object in reading a paper to-day is to form a text for some discussion.

The position of the hydraulic main is almost universally over the retort-benches—in a splendid place for all possible dirt, smoke, heat, and the general discomfort of the workmen who have to attend to anything in connection with it—more especially in the pleasing duty of "pipe-jumping," should chokes occur. Of course, the retort-bench offers a ready and inexpensive foundation for the hydraulic standards or crutches; but it may be open to question whether such a base as is offered by the retort-stack is the best for a reservoir which we desire to keep as level and rigid as possible. Some engineers contend that it is not objectionable for the hydraulic to be close over the retort-bench, and that the thick solid tar found in the vessel is not caused by the heat of the retorts. In "King's Treatise on Coal Gas," it is stated that: "Various means have been tried to prevent or clear out this accumulation of thick tar; one being an enlargement of the hydraulic itself, till, in one case that I [Mr. G. Livesey] have seen, each length would make a small Cornish boiler. Then the elevation of the hydraulic from two to four or five feet above the brickwork, with the object of removing it beyond the reach of heat; it being considered that the heat from the setting converted the tar into pitch. A stream of gas liquor has in some cases been caused to flow through the main; and for a long time I had a quantity of hot water from the steam-boiler put into the main once or twice a week. But this did very little permanent good. Making the main deeper, and square at the bottom, has been suggested. Means for drawing off the tar from the bottom, instead of the top, have been devised and used with varying success; but by no plan, so far as I am aware, has the prevention of this accumulation been certainly or completely obtained. The causes of its production are twofold—first, the retention of the tar in the main; and, second, the heat of the gas from the retort in passing through this comparatively stationary tar evaporating its volatile

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constituents; for *it is the hot gas, and not the radiated heat from the setting, that does the mischief.*" And further on, after describing how, by making the hydraulic shallower, and only allowing about 2 inches of tar below the bottom of the dip-pipe, it states that the tar kept "perfectly fluid;" there was "no pitch or thick tar, and no crystals of ammonia; . . . not a stopped dip-pipe all the winter, and stopped ascension-pipes were of much more rare occurrence." Perhaps, then, it may be a fair argument to say that the choking of ascension and dip pipes is not due to the close proximity of the hydraulic to the retort-bench; and that, therefore, on that account there is nothing to be gained by shifting it. Still I think the top of the retort-bench a most undesirable place.

Again, "King's Treatise" says that the saddles or standards supporting the hydraulic should have a substantial bearing on the bench, and their position is over the piers separating the ovens. But is a substantial bearing obtained on those walls that are part and parcel of the beds, and shift accordingly with their expansion and contraction? These party walls need renewal at certain periods, and then there is anxiety and risk. Strutting, slinging, and other means are resorted to, to maintain the hydraulic in safety, which might be avoided were the main supported on girders or columns independent of the brickwork. This was chiefly the cause of my placing the hydraulic at our works on girders and columns in front, and absolutely free of the retort-bench; so that any alterations or renewals of the brickwork could be carried out with perfect freedom from anxiety as to the safety of the hydraulic. The drawings I have here show how I have placed the main. It was done in a simple and cheap manner; the whole alteration, extending over seven beds of fives, costing under £40.

The idea of supporting the hydraulic other than on the brickwork is not a new one; in fact, it is an old and condemned plan. In "King's Treatise" we find it stated: "The hydraulic main is usually supported by cast-iron stands or crutches . . . . mounted on short brick piers, placed over the piers of the ovens, so that the main is at a short distance away from the front of the settings, and beyond the influence of the excessive heat. In the early period of gas lighting, the hydraulic main was cylindrical, and supported on cast-iron pillars, placed in front of the settings; but, owing to the prejudicial heat rising from the front of the bench when drawing the retorts, and the inconvenience of the projecting columns, this system is generally abandoned." From six years' experience, I demur to the indictment, both as to the prejudicial heat and the inconvenience of the projecting columns. The heat arising when drawing and charging

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is felt less on the platform than in the orthodox position of the hydraulic. The platform shown in the drawing is very handy for the workmen, and was much better for them than walking about on hot bricks. Anyway, whether the hydraulic is fixed over the brickwork or on girders, it is but due to the men that some provision should be made for as cool a platform as possible. The wooden battens of my platform are pretty dry by this time I expect, but they have not fired once during the six years they have been in use, with the "excessive heat," although the platform is only 8 feet above the highest mouthpiece.

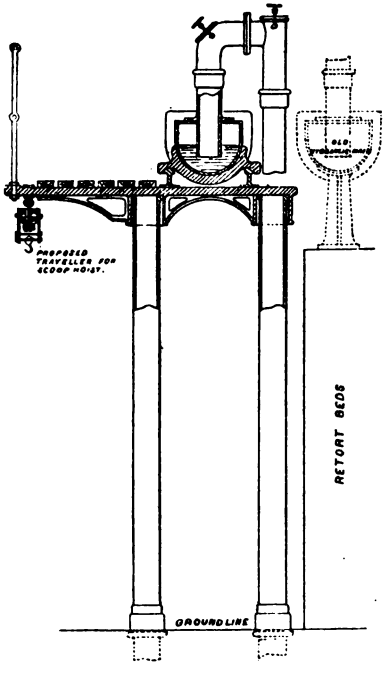

FIG. 16.—JERVIS'S ARRANGEMENT OF HYDRAULIC MAIN.

Having shifted the hydraulic main off the brickwork, I fancied there was not so much need to tie the piers between the beds by buckstaves back and front. The separate chimney system to each bed (which is now being tried, I believe, at Bath, and which we have followed for the past 14 years) interfered with bracing from end to end by angle-bars at the corners of the entire stack; and I could not, by placing buckstaves against the end walls of the bench, tie over the beds, as they were of different heights. Under the circumstances, I resolved to do without any bracing at all;

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but whether or not the proceeding was wise remains to be determined. There is some consolation, however, in noting that in this matter as in others, there are divers opinions, and that there are some gas engineers who still do without bracing. Even in "King's Treatise" it is said that some "engineers contend that transverse tie-bars and buckstaves are unnecessary, because at times the bars are burnt away at the centre and the heat causes them to expand. But if the tie-bars are fixed in the proper position, either above the brickwork of the bench, or carefully embedded in it out of reach of the heat of the flues, there is no danger of these burning away. Unless well bound together transversely as well as longitudinally, a bench will not endure the wear and tear of many seasons' working; the piers between the arches will inevitably bulge, and openings and crevices will appear between the ovens, admitting air and injuring the draught." Such is the text; and the matter of bracing seems to be so simple that there need be no fools.

There are one or two questions, however, that might be asked. Does not a long tie-bar—that is, from end to end of bench—allow of a good bit of expansion of brickwork? Except on account of the hydraulic main, do the middle or inside beds of retorts require longitudinal aid, inasmuch as they have the support of their neighbours one against the other? Is it sufficient therefore to buttress or otherwise stay the end beds only? And when an arch is taken down, is the temporary strutting on account of the hydraulic, or purely on account of expansion? Is the matter of checking the expansion by tie-bars a question only of how much? The heated brickwork *must* go somewhere; and the only consideration, I take it, must be which way? If the arches cannot spread, they must rise; and if the front walls cannot come forward, the rear ones will go backwards.

The point I wanted to decide was whether after all, when I had relieved myself of care in regard to the hydraulic, I need trouble anything about bracing the retort-bench. I found from four years' experience without any bracing, that the inside piers remained plumb; and the end one only went over about 2 inches in a height of 9 feet. The face ends of the pier walls had come forward about 3 inches, which would have been a bad thing for the hydraulic had it stood on crutches there. The expansion of the retorts, back and front, was not more than previously; but, altogether, I was convinced that some bracing is better than none at all, even though it be only from end to end over all. There will be more or less expansion with the best bracing; but there will not be the excessive expansion there is possible where no ties are made

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use of. The retorts "go" with the brickwork; and the cracks in them are not so readily repaired as in the walls, &c. I therefore determined to again brace up; but brace over all I could not. Mouthpieces at different levels in front, separate chimneys to each bed behind, and unequal heights on the top, precluded the use of long ties.

As in retort renewals I generally clear the arch right out, I wished to avoid all necessity of strutting, and have as clear and cool a working space as possible. I meditated some accommodating bracing. "Necessity is the mother," &c.; and the drawing herewith shows my "invention." It may be thought complex and unnecessary; but, of course, I deem it just the thing. Anyway, it

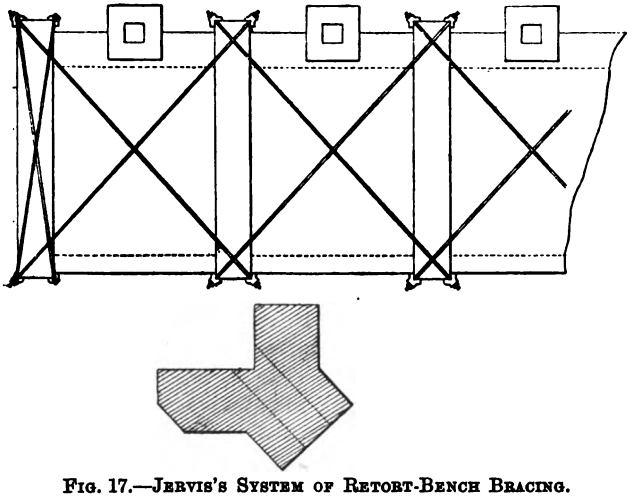

FIG. 17.—JERVIS'S SYSTEM OF RETORT-BENCH BRACING.

has been satisfactory so far. Each bed is independent of its neighbour; and any bed may be cleared right away without occasioning any alteration of the tie-rod, &c. The short tie-rods will not allow of so much expansion as longer ones; and the placing back of the face of the bed 2 inches to form a corner for the angle-bar, does not interfere with the setting of the retorts. The "go" of the expansion of the retorts is directed by the angle-bars to the back wall rather than to the front; and the mouthpieces and ascension-pipes consequently keep plumb. The cost of bracing the seven beds in this manner was under £45.

Discussion.

The PRESIDENT thought that the meeting had just heard a very practical paper. Mr. Jervis had given good reasons for removing the hydraulic to beyond the front of the retort-bench; and it seemed

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to have answered well in his case. At the same time, some managers were not much troubled with thick tar. At Trowbridge he had not cleaned out his hydraulic for several years ; and yet had not found that thick tar accumulated to any considerable extent. He had personally inspected the arrangement described by Mr. Jervis, and could testify that the woodwork did not burn away.

Mr. W. Fiddes (Bristol) said he had tried to do without bracing with through settings, 20 feet in length ; but they split and separated from the piers, at about 3 feet from the front of the setting. It was therefore necessary to put up buckstaves and tie-bars. He also found considerable improvement by putting on the top of the pier before turning the arch, a sort of " bond timber " made of very large fire-clay lumps, each about 2 feet in length, splayed to take the springing of the arches. The plan served to tie in the brickwork to a considerable extent ; but not sufficiently so to dispense with the buckstaves and tie-rods. It was difficult to get buckstaves that would hold. The cast-iron ones would snap suddenly, without warning ; and those made of wrought iron buckled and gave way gradually. Of course, as soon as a buckstave failed, it was necessary to renew it, or damage to the setting would speedily follow. When a setting was lit up, it expanded about 3 inches in the direction of the length, and 2 inches in height. So whenever the heat of the retorts was increased, the rule should be to slack the nuts of the tie-rods, and *vice versâ*. In order to meet this variation, he had tried bell-cranks and a system of counter-weights to take the leverage. But this failed. Then he substituted lead, or lead and tin washers, thinking they might squeeze together gently. This, however, was not so successful as careful attention to the nuts, letting out half a thread or so each morning and night until the maximum expansion was obtained when lighting up. In cooling down, the furnace was filled with fuel, the damper shut, and the ash-pit and door carefully covered up, so that no cold air could enter. The retort-lids were all carefully screwed up ; and when this plan was followed, two or three weeks elapsed before the setting got cool. The retorts lasted from 1200 to 1400 actual working days. When letting down, it was a good plan to seal up the mouths of the retorts with 4½-inch brickwork, to prevent loss of heat ; and the same might be done with new settings adjacent to those in use. For about 40 years he had worked with separate chimneys to each bed, very short, not more than 2 or 3 feet above the top of the stack. By this means, he secured better heats with less fuel ; and therefore always adopted that plan.

Mr. J. Lowe (Weymouth) remarked that, having had great trouble with cast-iron buckstaves, even when " bellied " so as to

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be stronger in the centre, he hit upon a cheap and effective wrought-iron buckstave. It was made of two second-hand railway irons, strongly clamped together. The cost of these discarded rails was only about 80s. per ton for small quantities, and somewhat less for large; so that a 10-feet buckstave cost him about a guinea. Made in this manner they were about 5 inches square; so that with 14-inch partition walls, and retorts close to the side wall of the setting, it might be necessary to keep the ascension-pipes out a little, in order to clear them.

Mr. S. W. DURKIN (Southampton) said he had long been of opinion that some simple plan for bringing the hydraulic out from above the top of the stack was advisable. As at present fixed, it seemed altogether in the wrong place, particularly where there were long rows of beds. When letting some of the beds down, it was necessary to have the hydraulic main levelled; and the same when re-lighting, when working with the shallowest possible seal, as he was now doing, as the hydraulic should be perfectly level. Mr. Jervis's plan would enable the hydraulic to be kept level. Formerly he was much troubled with thick tar; but a few years since he adopted a plan, which he had already described to the Association, for taking off the tar from the bottom of the hydraulic. It was a simple arrangement, with no weir overflows. He used through retorts 20 feet in length, with a hydraulic at each end; and in both the tar was taken off at two points. He also made a connection between the hydraulic mains and the liquor-pump outside; and every day he pumped some liquor through the mains and overflows, and this washed away any accumulations of thick tar. By this means, also, the dips were sealed in liquor, and not in tar; the gas was washed by passing through the hot liquor; and the whole kept clear. Recently he had overhauled a hydraulic which had not been opened for two years; and found very little thick tar in it. Temperature had something to do with the formation of thick tar in the main, as there was a tendency in that direction in cold localities, when the main was over beds that were out of use. He was therefore pleased with the success of his arrangement, as saving the great trouble and labour involved in getting deposits of pitch out of the hydraulic. Referring to retort-bracing, he said that he remembered using nothing in years gone by but iron retorts; and these never strained the benches so much as clay retorts, which were brought more immediately in contact with the arches. In some settings of iron retorts, the tie-bars had actually been built into the brickwork; and when taken down for re-building, it was found that the tie-bars were quite carbonated and rotted away—being merely kept

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in position by the brickwork. He had used a rather ingenious form of buckstave. It was made of cast iron, with a groove in which a fish-plate of wrought iron was fitted. These were displaced by cast-iron T-shaped buckstaves, "fish-bellied" in section, which did not answer, as they were liable to snap suddenly with a loud report. Even when made thicker, and therefore stronger in section, this objection still obtained. Wrought-iron buckstaves were then introduced; and he had some that had been in use for 20 years. They were still perfectly sound, except at the lower end, where they were corroded by the water used in extinguishing coke. He had arranged a cast-iron channel to keep the water away and protect this part of the buckstaves. The tie-bars were nearly all on the outside of the brickwork—transverse as well as longitudinal; and he condemned the plan of burying tie-bars in brickwork. They should all be in sight. He quite agreed with Mr. Jervis, that brickwork would "go" somewhere. If tied at the top, it would go at the centre; and if the transverse tie-bars held on, the walls would expand, and the bars would bend, but they would not break. He need scarcely add that if they did break, it would be a serious matter, and would destroy the draught and injure the retorts. Mr. Jervis's system of tying was interesting; but whether it could be adopted to through retorts, he was not prepared to say.

The PRESIDENT remarked that at Trowbridge the tar was taken off from the bottom of the hydraulic, and perhaps this was the reason why he had very little trouble with thick tar. He quite agreed that the bars should be outside the brickwork; and he had tried protecting them by enclosing them in drain-pipes, but still they would break off at the point of fiercest heat.

NEWS FROM AN OLD MEMBER.

The PRESIDENT said that Mr. Walter Thomas, lately a member of the Association, but now removed to British Columbia, had addressed an interesting letter to the Honorary Secretary, relating some of his experiences since leaving England. He thought some extracts from the letter would be interesting to the meeting, as showing how one of their brotherhood had successfully dealt with unusual difficulties.

The HONORARY SECRETARY thereupon read the letter which he had received from Mr. Walter Thomas, as referred to by the President, in which he described his experiences in establishing gas-works in the town. He said he had been compelled to erect the greater part of the works with his own hands, not having skilled labour;

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but they were then in working order, and successfully competing with electricity.

Mr. W. Davis (Poole) next submitted the following paper :—

A REMEDY FOR NAPHTHALENE.

Having been requested by our respected President to give a short extract from my experience as a manager, and as I consider it is the duty of every member of this Association to promote the interests of our profession by promulgating all the information he can, it has occurred to me that, by briefly stating my experience with that great pest to many gas managers—naphthalene—I may interest, even if I cannot much instruct my professional brethren.

Some years ago I had the management of a works where there were four purifiers 10 feet square ; and they were fixed in such a position that the inlet-pipes from the hydraulic centre-valve had a fall into the purifiers. Consequently, when these were emptied, it was frequently necessary to clear the condensed matter from the bottom ; and what made things worse, the scrubber was a very small one—about 18 feet high by 6 feet diameter—through which ammoniacal liquor was continually being passed in the usual way. The distance between the scrubber and the centre-valve was only about 25 feet. Therefore, it was only natural that a large quantity of condensable moisture would be carried forward, and deposited in the bottom of the purifiers. In order to obviate this, as I happened to have four 16-inch pipes (12 feet long) in stock, I put them up in the form of a condenser. These pipes were fitted from bottom to top with 9-inch by ½-inch boards, cut in lengths of the diameter of the pipe, and placed cross-ways ; thus giving a large rubbing surface for the gas in its passage to deposit the moisture carried forward from the scrubber. This, I was pleased to find, had the desired effect. It also produced an effect that I had not anticipated. I had previously been very much troubled with naphthalene ; the inlet and outlet of the station meter having been frequently choked up with it, and also the pipes leading to the holders. The inlet and outlet pipes of the holders were likewise a constant source of trouble. After the introduction of these pipes (which I have since termed "depositors") I was not troubled with naphthalene. This led me to investigate the cause of the naphthalene formation. As many crystals contain what is termed the "water of crystalization," I at first came to the conclusion that I had made a discovery ; but after consulting a very clever chemist, I found that these crystals do not contain that water. We then came to the conclusion that the crystals were produced by synthesis, and that the presence of moisture caused its production. Whether or

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not this is really the secret of its formation, it is a fact that, by carrying out this arrangement in works that I have since erected, I have not been troubled with naphthalene.

Discussion.

The PRESIDENT said that, speaking generally, naphthalene was not so troublesome now as in former years. He had known the inlet and outlet of the station meter to be choked in about a month, at a time when a part of the condenser had been out of use. But, by working the condenser regularly, and keeping the whole of it at work, he had not seen a stoppage with naphthalene for more than 20 years, although he had continued to use the same kind of coal and to work under similar circumstances. As to the effect on the public lamps, he remembered that once, after a continuance of hard frost and bright sunshine, on a certain Sunday night, the lamplighters could not light a single lamp in the main street. This was not due to naphthalene, but to moisture frozen in the pipes, and melted by the sunshine alternately; so that it gradually found its way to the bend at the bottom of the lamp-post.

Mr. J. H. CORNISH (Bridgwater) observed that some years ago he had much trouble with naphthalene; both the inlet and the outlet of the holder being choked. He employed steam to remove the deposit, and this caused the pipes to expand and occasioned a leakage into them from the inside of the tank, which could not be remedied without emptying it. A plunger was then used instead of steam, to clear the pipes; and this proved effective, at the same time dispensing with the disadvantage just named. He could recall instances when more than half the public lamps were out. But by adopting a large foul main, three times the length of the retort-house, and by more gradually condensing the gas, he completely got rid of trouble from naphthalene.

Mr. N. H. HUMPHRYS (Salisbury) remarked that there was no doubt as to the fact that naphthalene deposits were caused by improper or too rapid condensation of the gas; but he thought there were instances on record—some had been cited before the Association—of naphthalene being formed from gas that had been properly condensed and purified in accordance with the latest state of knowledge on these subjects. This seemed to support the view expressed by Mr. Davis, that under certain circumstances naphthalene might be formed by synthesis; and it would be interesting to have further information on the point.

Mr. R. BEYNON (Torquay) said he had not succeeded in completely overcoming the naphthalene difficulty, and was going to erect a larger foul main. In 1885 he was only troubled in the winter—from December to February. He had an ordinary annular

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condenser; and a friend advised him to cover it up during the next winter. In 1886, he covered it with sulphate-bags. This was effective to the extent that, whereas he formerly had a dozen complaints per day, they came down to one or two. But now he suffered mostly in the autumn between August and November, and most seriously in the mains and services. This he ascribed to the greater ranges of temperature prevailing at that period of the year. He read in the *Journal of Gas Lighting*, that Mr. Duxbury, of Darwen, had experienced much the same thing.* He considered that it was to the regulation of the condenser that they must look for a cure.

Mr. H. G. Crowe (Wellington) remarked that he had a friend who was troubled with naphthalene. In this case the hydraulic main was carried down the centre of the retort-house; and there was a bench of retorts on each side—the one hydraulic serving for both sets of benches. His friend attributed the naphthalene to the position of the hydraulic. He inquired whether Mr. Jervis had found the alteration he had described in his hydraulic had any effect as to naphthalene?

Mr. Jervis: I do not know what naphthalene is.

Mr. A. Thomas (West Cowes) said that some little trouble from this source had fallen to his lot in times gone by. In the case of one particular length of main about half a mile from the works, every winter it would gradually fill up until the supply was entirely stopped. The first year he cut out a long length of the pipe, and found to his surprise that it was quite clear. The jarring had caused its dispersion. Afterwards he tried drilling a hole and pouring hot water down the main, which proved a cure. He also found that the application of a force-pump would remove it. But after he had started new works with a foul main and good condenser, he lost sight of the naphthalene. He therefore concluded that the foul main and the condenser furnished the cure; and that previously his gas had not been properly condensed.

Mr. S. W. Durkin (Southampton) said that naphthalene was an old friend of his. The farmers complained of the present season, but more equable temperatures had prevailed, which were favourable to those who were troubled in this way. He was generally harassed by naphthalene in the autumn, or whenever great differences of temperature prevailed, such as alternations of bright sunshine and cold nights. Yet for nearly twelve months he had hardly known what it was. He had a set of men whose duty it was to attend to complaints of this sort; and he scarcely knew what to give them to do. Last winter he went on very well till

* See Inaugural Address to the Manchester Institution, *ante*, p. 54.

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after Christmas; and then he had a 16-inch pipe choked on the works, and this sorely perplexed him. This particular piece of main happened to be laid deeply in the ground; and he imagined there was some tidal influence which kept its surroundings cold and damp, and so caused the formation. He had a great belief in the foul main, and thought it possible that his present provisions in this respect were not large enough; and when a larger foul main was fixed, he hoped to see the naphthalene disappear altogether. As a proof of the fact that temperature had a great deal to do with the formation of the naphthalene, he might add that he never knew any to form near the station meter, which was kept at an equable temperature. Attention to this point, he believed, would avoid trouble at the meter.

Mr. W. Fiddes (Bristol) remembered that on one occasion, several years since, he was with the late Mr. George Lowe in London, when they were opening the ground to discover the cause of a stoppage in the gas-mains that supplied the Houses of Parliament. There was an 18-inch branch main, from which two 4-inch mains were taken off, and ran parallel to each other for some distance. One of these parallel mains was continually having to be stripped in order to clear away naphthalene, but not a particle was ever found in the other. He had had a great deal to do with naphthalene deposits himself, and was inclined to think that large main-pipes greatly reduced this pest. Some years ago they had smaller connecting-pipes about the works; but now it was the custom to use larger ones; and 24-inch pipes had been laid down in place of 9 or 10 inch. At one station it had been the rule to clean out the inlet and outlet pipe of the holders every Sunday. He had known 7-inch holder connections completely choked, and 12-inch ones not much better; but now he used pipes not less than 24 inches in diameter for holder connections, and had not been troubled with naphthalene for a considerable time. In one particular case, a holder outlet-pipe remained perfectly clear for six years, and then choked suddenly; so that the gas could not get out of the holder. To remove it he used a small boiler, and a 1½-inch pipe carried down to the syphons inside. Some naphtha was heated in the boiler; and the vapour dissolved the naphthalene, and brought it down in a liquid state, so that it could be readily pumped out of the syphons. By this means the pipes could be readily cleared in two hours. He thought the naphthalene formed over the top of the pipe something in the shape of a mushroom; and after a time broke up and fell down the pipe—thus causing the sudden stoppage. The average temperature of the water in the holder tanks would

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be something like 56°; and he had observed that if the temperature fell much below this, they were sure to be troubled with naphthalene, if not in the holder connections, in the mains or services. The lights in the street lamps would be reduced to the size of rushlights; and the stoppage would, strange to say, follow regular lines in the direction of the points of the compass—running north-west one time, and in another direction at another time. Wherever the main was situated in low, damp, and therefore cold ground, he found the deposit take place. He also discovered that the deposit favoured points of junction of dissimilar metals—such as a lead service joined to a cast-iron main. It might therefore be questioned whether the magnetic influence of the earth, or electrical influences, had anything to do with the deposit. This, of course, was merely a suggestion. There was no naphthalene where cannel gas was supplied; in that case it appeared to go into the tar rather than the gas. But where Somersetshire coal was used, it seemed to go into the gas. The subject was most complicated; and it was only by careful observation that a sure remedy could be discovered.

Mr. Davis, in reply, said he had often heard it remarked that a very short paper would bring about a good discussion; and it was a pleasure to him to see that the few remarks he had hastily thrown together had elicited so much information. He thought his argument, that moisture was somehow concerned in the deposit, was fully borne out by the various speakers. Twenty years ago the theory was first propounded, that the tar and gas should be kept together in the foul main for a time, in order either to fix the naphthalene in the gas, or to take it out in the tar. He adopted this plan at the works where he was then engaged; but he left there before the effect could be ascertained. He heard, however, that it was not altogether a success. At his next works the condensing and purifying plant was small in proportion to the quantity of gas made. He tried to reduce the moisture; and in so doing, decreased the naphthalene to such an extent that it did not give trouble anywhere except at the holder connections. Singular to say, the inlet choked in the spring, and the outlet in the autumn; but they never choked together. These were the facts; but he could not explain them. Perhaps in the autumn the heat of the sun had more power, and the temperature was higher; so that the naphthalene was vapourized and carried to the outlet. At this season of the year, too, it had been remarked that naphthalene was liable to form in the mains. Perhaps the heat of the sun vapourized the water in the holder tanks, which, being carried forward with the gas, stimulated the formation of naphthalene

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He did not know whether or not electricity had anything to do with it. It might have, as water would tend to convey electricity. But he had come to this conclusion: If the gas met with moisture anywhere between the retort and the burner, and was afterwards exposed to cold or damp, then naphthalene was formed. It would be remembered that M. Brémond had proposed to desiccate the gas by means of lime—a plan that was found effectual in preventing naphthalene.*

Gasholders with Spiral Guides.

The President said that Mr. W. Gadd, of Manchester, had been kind enough to bring models of his patent system of gasholder construction [see *ante*, p. 243], to show the members; and he would now ask him to explain them to the meeting.

Mr. Gadd said that he would briefly describe his invention, beginning with the model of the single-lift holder. He would cause it to rise; and it would be seen that it was guided from the bottom entirely, there being no columns or girders above the ground. Yet it was held rigidly all round the bottom; each guide forming a holding point. Taking a hat, he might illustrate the ordinary way of supporting a holder with columns and framing, by supporting the hat on a stick from the centre of the crown inside; but in his system, the hat would be held down at points equidistant round the rim. The rollers played in lines preferably tangential; but this was in nowise a part of his system. They could be radial if desired. The guides in the tank, instead of being vertical, were disposed at an angle, forming a spiral, or deep thread of a screw. The angle might range from 45° to 60°; and anything between these limits was workable. Each roller formed a point of support; so that the holder was held in just as many places round the ring as there were guides. In the model before them there were six. Each roller formed a solid bearing; rendering the holder as stable as if it was resting on the floor. There was first a slight play on the bearings; and then the whole structure, holder and tank, could be turned bodily over as if one piece—the holder being gripped by the guides as in a vice. The holder formed a cantilever of the elbow kind—the height being the extent of one limb, and the diameter that of the other; so that if the wind pressure was concentrated at the top, the resisting leverage would still be much longer than the acting leverage. Another advantage obtained was that the pressure was rendered vertical. The shallower the holder, the more capable of resistance

* A translation of M. Brémond's paper, in which he described his experiments, appeared in the *Journal of Gas Lighting*, Sept. 25, 1877 (p. 491).

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did it become; and in this respect it was just contrary to the ordinary system. He could make a very shallow frying-pan-like holder that would be perfectly stable. To illustrate the effect of unequal loading, such as an accumulation of snow on one part of the top, he would place a pile of lead weights near the circumference; and it would be seen that the holder rose and fell vertically, without tilting or straining. This showed that under any circumstances the strain on the guides was perfectly vertical. There could be no tilting, because the guides pointed in opposite directions on opposite sides of the tank; and therefore the rollers were gripped as between the blades of a pair of shears. He then showed the working of the three-lift model holder. The principle of his invention, he went on to say, was not affected by the manner in which the rollers and guides were designed; for instance, the rollers might be fixed on the tank, and the guides on the holder if preferred. The rollers could be built in the tank, in recesses of solid masonry, or the same might serve for the guides. In fact, the actual working arrangements might be modified in any practical way. The whole depended on the screw action. The three-lift holder might be compared to three screws, one inside the other. The interior framing, especially of telescopic holders, would have to be modified considerably to meet his system. The uprights could be made triangular in form, with base at the bottom of the curb, which would give more strength, and at the same time use no more weight of metal. The rollers could be double flanged, single flanged, or made in pairs without any flanges, having the guide between them.

Mr. Walter Fiddes (Bristol) said he remembered that, when he was a boy, his father made a model holder without columns and girders, guided by a central column, having a coarse screw on it for the rollers to work in. He asked if Mr. Gadd had any idea of the increased pressure that would be given by a holder on his system, as compared with the ordinary ones. Supposing, as was often the case, that 100,000 cubic feet of gas per hour were being delivered into the holder, and 300,000 feet per hour were passing out at the same time. Circumstances would differ from the ordinary working, because there would be the effect of the lateral motion, and also the fact that the bottom must be heavier. The conversion of all wind pressure, &c., into a downward vertical strain would tend to influence the degree of pressure given by the holder. A heavy wind would increase the pressure. In connection with wind pressure, he would ask if the sucking or vacuum on the lee side, as well as the direct force on the windward side, had been taken into consideration. This was very considerable, and acting in the

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same direction, practically increased the wind pressure. He had known the barometer on the lee side of a holder, during a strong wind, to stand 8-10ths of an inch lower than on the wind side. So the real wind pressure was really represented by that experienced on the windward side, *plus* the exhaust on the lee side. There was much difference of opinion with reference to wind pressure, the range over which it should be taken, &c.; and he thought that very few really understood the force of wind.

The PRESIDENT believed that the models before them to some extent represented the gasholders of the future, though all might not live to see them.

Mr. GADD thought that the difference of pressure between a holder on his system and one on the ordinary plan would not be appreciable. Certainly in his case there was a slight lateral motion to overcome; but when the holder was floating in water like a ship, the force required for this would be very slight. A boat could be pulled along in still water with very small force, and twisted round with still less; and there was only the slight twisting action to be overcome in his holder. This might make it a trifle lighter in rising and a trifle heavier in falling; but he could say that it was so slight as to be quite inappreciable in the models, and he had tried one model 6 feet in diameter. It was simply a matter of the friction of the core of gas on the water and iron, and also of the part of the iron that was immersed on the water. As to the force of the wind, the Tay Bridge disaster showed our want of knowledge on the subject; but he had calculated on the data usually accepted by engineers. No doubt there was at times a violent wind action exerted over a small space. He thought his experiments showed that the degree of stability afforded by his plan was far greater than that of ordinary columns and guide-framing. He hoped before long to institute a series of tests, carried out to the point of fracture, which would effectually determine this matter. He would be quite satisfied to submit his system to any test of that kind, to see whether a greater force would be required to determine fracture than in the ordinary holder.

Mr. A. THOMAS (West Cowes) read the following description of

A PRESSURE-GAUGE HAVING NO FIXED JOINTS.

Pressure-gauges, as you are aware, although only small articles, are very important ones in gas-works. We frequently look at them as we pass from one part of the works to another, and become so used to seeing the water-line at about one height that I think if it altered only half an inch we should detect it. The pressure-gauge is the manager's friend, as it gives him timely warning of

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any coming stoppage. It is the "weather-glass" of a gas-works —the foreteller of coming trouble; and although the manager dreads the stoppage, especially in winter, yet he is pleased to know of its approach before it actually takes place. What could we do without the pressure-gauge; and yet what appliance is there so frequently out of order. In saying this, I allude to gauges used for foul gas. How often has it occurred that, when some of the men have reported that something is wrong at the condenser or scrubber, or that gas is "blowing" at such a point, and we go to the gauge to find out what increase of pressure there is, we cannot even see the water in the glass, it being so foul. Then comes the scolding of the man whose place it is to keep the gauges clean; but all the scolding in the world does not rectify the matter. It must be cleaned; and how often the glasses are broken in doing so. Then a gauge has to be brought from some other part of the works, and valuable time is spent in removing and refixing. The question is asked, "Why is the gauge not kept clean?" and the real cause is found to be that the men dread the cleaning, as the glasses so frequently break with the least touch. I believe the men would prefer working up to their elbows in tar than have to clean some of the gauges in use at the present day; and the question with me has been, Why are gauges so complicated and delicately made?

The pressure-gauges of the present day that I have seen are altogether behind the times. Efforts have been made to beautify their outward appearance; but very little has been done to simplify them. Many of them are so tender that the least touch breaks them; and some will break even without a touch. So long as glass is fixed to brass or any other metal, just so long will the gauges be a trouble and a nuisance to both man and master.

Some years ago, when at Alton, I had a serious stoppage on the works; and when I went to the gauge to examine the pressure, the glass was so foul that I could not see the water-line, and trying to clean it in a hurry, as a matter of course, I broke it. It being necessary to know the pressure at once, I obtained a long bottle; and, putting a piece of glass tube into it, used it as a pressure-gauge, and from that I took my first idea of the gauge you have before you. I do not for a moment claim that using two glass tubes, one inside the other, is new, in whatever form they may be; but the general arrangement of the gauge, together with the rule being in the centre, acting for two gauges, is new—at least, the Patent Office admitted it was so, for they granted a patent for it. The gauge is made of glass tubes one inside the other. The brass mountings are steel-bronzed, or can be plated. The rule is made of boxwood; and the wooden back is polished.

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I think with the ordinary gauges there are as many glasses broken by expansion and contraction of the metals surrounding them, as there are by the men when cleaning them; but in the case of the one before you, there is no possibility of breakage from undue expansion or contraction, for the reason that there are *no fixed joints*. What I have aimed at, in producing the present gauge, has been to do away with the trouble the ordinary gauges give in cleaning, and the risk of breakage when doing so. This I think you will admit, I have accomplished. Then, again, I have aimed at making a gauge that can be easily cleaned by an ordinary man or boy upon the works, and one that requires no skilled labour to fix. This I think you will also admit I have done.

The kind of gauge required for use in a gas-works, where the pressure of crude gas has to be ascertained, is one that stands out bold and clear, and in which the water-line can be plainly seen. Such a gauge you have before you. We want a gauge that can be handed about without the fear of breakage—a something without the delicacy of the present style of gauge; so that, if it should be broken by accident, it can easily be repaired. Another thing about a gauge is that it should be so made that it can be taken from one place to another for use, if required, without any trouble in taking down or refixing; and with my gauge, all that it is necessary to do is to loosen the flexible tube, lift it from the nail, and it is ready for use in a moment where required.

While I am mentioning the fixing of gauges, I should like to say that when preparing the pipes for them, it is best to bring them up the walls on either side, and fix the tap below the gauge, and finish with a T, 3 inches above the gauge, taking the supply from the side outlet, and fix a small tap upon the top of the T. If this is done, you will have a supply of air between the lower tap and the water in the glass tube, instead of crude gas; and if these taps are turned once a day, so as to allow the water to run level, the gauges will operate for a long time without getting discoloured, as you will have air only pressing upon the water. Nine inches of flexible tube is sufficient for each gauge.

Then another thing about a gauge is its cost. I am told that the price charged for 12-inch gauges and upwards is 1s. 6d. per inch. This, however, does not apply to gauges under 12 inches; for the one upon the table is a 6-inch, and cost, I believe, 14s. 6d. When you examine it, I do not think you will consider it is dear. It is a fair sample of an ordinary gauge, well made, and manufactured by a good firm; but there it is, both glasses are broken, and that without the help of man. It was broken by expansion or contraction while hanging in the office. I may say broke itself; but

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the one I bring before you to-day is not guilty of such tricks, for in it nothing is set fast, yet sufficiently fixed to produce a good, useful, and reliable gauge. As they are made chiefly for use where the pressure of crude gas has to be indicated, and where it is necessary to have both inlet and outlet before you, they are made in pairs, and commence at 12 inches, though shorter can be made if required for the inlet and outlet of governors, where excessive pressure is not likely to be met with.

The question of marking the rule has been raised. Some gentlemen think it should commence at the bottom, others that it should begin at the top. I have some made both ways, and have come to the conclusion that it would be better to mark them at the inches with the figures 10 to 20, and so on, from one end of the rule to the other. To have a zero upon a rule is a farce; for if you water the gauge to zero to-day, how long does it stay there. Which of us here can remember if the water was at zero when we left the works to attend this meeting, and which of us will complain if it is not at zero when we return. If the inch lines are carried across, and the half-inch lines half-way across, you then have all that is necessary for ordinary working purposes, without the tenths being upon the rule. I am now speaking of the manufacturing department. For "finished" gas, I admit that tenths are required; but as it costs nothing to put them on, perhaps it is as well to let them appear.

Discussion.

Mr. J. J. Jervis (New Swindon) said he had pleasure in testifying to the efficiency of Mr. Thomas's gauge; having used one similar to it at his own works for the last six years. But he put india-rubber stoppers at the bottom of the large tubes in preference to making them solid. In this form the water was never blown out; and he would not think of returning to the old U-tube gauge. [He exhibited the gauge referred to, which was made years ago from his own design.]

Mr. H. G. Crowe (Wellington) remarked that he too had had a gauge on a similar principle, consisting of a glass tube immersed in an hydrometer glass, in use for some years.

Mr. J. Lowe (Weymouth) thought that Mr. Thomas had put a new dress on a very old friend. He had known the principle for 25 years. About five years ago, he was induced to design a new gauge for his exhauster-house; and he fell back on this plan, adopting with it the method of making a rubber joint for a steam-gauge. He had only used this arrangement [which he exhibited to the meeting] on the exhauster. It consisted of a hydrometer glass, and an inner tube, kept in position by metal clamps, and graduated in inches. The gas supply was connected to this by the

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steam-joint above named. He preferred that the inner glass tube should be of the kind lately adopted for boilers—having an opaque half with a thin red line, as this clearly showed the water-level. The advantage of this form of gauge was that it showed the vacuum as well as the pressure on the one tube. It could be very easily fixed, or made up to any length; and his was provided with an air-cock on the top. It was easily cleared; and he strongly recommended it as superior to the ordinary form of gauge.

Mr. S. W. DURKIN (Southampton) said he had tried one of Mr. Thomas's gauges, and used it in conjunction with one of the ordinary U-shape. With regard to the latter, he was occasionally troubled by the glass-tubes breaking. He connected up with rubber joints; and if the ordinary gauge had a plug at each end of the tube, there was not much difficulty in keeping it clean.

Mr. W. FIDDES (Bristol) said that this form of gauge was very old. One pattern, made of tin, would have been seen by many present. There was an outer cylinder 5 or 6 inches in diameter, and an inner tube; the gas being admitted to the space surrounding the tube. There was a float, having a wire pointer which extended above the inner tube, and worked in conjunction with an index, and also a little whistle which sounded when a certain pressure or exhaust was exceeded.

The PRESIDENT said that, while there was "no new thing under the sun," Mr. Thomas had certainly shown an apparatus which was a great improvement on the ordinary form of gauge. One would hardly think a simple pressure-gauge could be the subject of so much discussion. With regard to the escape of gas in blowing, he observed that, in Mr. Lowe's arrangement, a very considerable quantity—enough to cause an explosion—could get out in this way. In the old gauge the tubes were smaller, so there would not be so much loss. Therefore the smaller the diameter of the centre tube, the better.

Mr. THOMAS was glad so much attention had been given to gauges, which had always seemed to him to be rather neglected. As to the principle, he had used it for the last 18 years or more; but had only lately applied it in designing a simple and cheap form which could be easily cleaned and was not liable to be broken.

VOTES OF THANKS.

Mr. LOWE propose a cordial vote of thanks to the gentlemen who had contributed to the proceedings at the meeting; coupling with the vote the name of Mr. Gadd.

Mr. T. W. R. WHITE (Sherborne) seconded the proposition, and it was carried unanimously.

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Mr. T. HARDICK (Salisbury) proposed a vote of thanks to the President for the energetic and able manner in which he had conducted the affairs of the Association during the past year.

Mr. CROWE seconded the proposition, which was agreed to.

The PRESIDENT responded, and proposed a vote of thanks to the Honorary Secretary and Treasurer.

Mr. DURKIN seconded the motion, and it was carried.

Mr. HUMPHRYS having replied, the proceedings terminated.

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EASTERN COUNTIES ASSOCIATION

PRELIMINARY MEETING, SEPT. 26.

On Wednesday, Sept. 26, a meeting of gentlemen having the management of gas-works in the Eastern Counties was held at the Peterborough Gas-Works, in accordance with circulars issued by Mr. H. Wimhurst, of Sleaford, to consider the practicability of forming a Gas Managers' Association for the Eastern Counties.

Mr. W. BARRATT (Grantham) having been elected to the chair,

The SECRETARY *pro tem.* (Mr. H. Wimhurst) read the circular convening the meeting, which he had issued with the co-operation of Mr. J. Barton, of Peterborough, and Mr. J. Carter, of Lincoln. They had, he said, received 24 definite replies in favour of the formation of an Association. Some of the gentlemen to whom circulars had been sent (and whose replies he read) were undecided; a few were unfavourable to the proposal; others considered themselves situated in out-of-the-way places; while one or two intended waiting to "see what steps The Gas Institute would take in their present difficulty."

The CHAIRMAN remarked that, having heard the communications *pro* and *con.*, he presumed the matter they were to settle was whether or not there was to be an Association. They had heard what had been stated by those who were unfavourable to the project; and now he should be glad to hear what any gentleman present had to say with regard to it—whether or not it was necessary to establish an Association for the district. Personally, he considered it essentially necessary. He thought they must have all come to the conclusion that it was time something was started to get them out of the difficulty in which they were now placed. It had been a matter of surprise to him, and he had mentioned it more than once to his brother managers, that that part of the country—he would stand corrected if he was wrong—had only been once represented in what he might call the parent society, and that was by the gentleman who was at Grimsby, and whom Mr. Jowett succeeded.* This state of things he thought ought not

* It may be pointed out, in reference to this statement, that the Transactions of The Gas Institute show that Mr. G. Ernest Stevenson, formerly of Peterborough, was a member of the Council from 1881 to 1884.

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to exist at all; it appeared to him to be rather one-sided—perhaps more one-sided than it should be. He should be glad to hear what gentleman present had to say as to the necessity of an Association being established.

Mr. W. J. Best (St. Ives) asked what the "Eastern Counties" comprised.

The Secretary replied that, in sending out the circulars, he had included the whole of Lincolnshire, Cambridgeshire, Norfolk, Suffolk, parts of Essex and Huntingdonshire, Northamptonshire, and a little corner of Nottinghamshire. He also went up as far as Doncaster, as he did not know whether they might not get Mr. Bridge. Altogether, he sent out about 250 circulars.

Mr. J. Barton (Peterborough) said he thought the time had arrived when they ought to form an Association for the Eastern Counties. When he first came to Peterborough, he felt very lonely indeed. He did not know his neighbours; and he did not suppose he had been to half-a-dozen works since then—some four years ago. When they had not an Association, they had not so much freedom; they could not go and inspect gas-works and make friends with the manager when they did not know him. They wanted a sort of introduction. If they had an Association, it would bring them together, and they could talk over affairs, compare notes, and exchange ideas. No doubt, as they went along, they would visit different works; and no matter how small the works might be, they would pick up something new. He thought when they became associated together in this way, it did a very great deal of good. They would have to arrange rules that day. They wanted to begin right; and if they began right, they would end right. He considered they had sufficient promise to warrant them in starting an Association.

Mr. Best said that he had felt like Mr. Barton. When he first came into the Eastern Counties, he did not know many gentlemen. They had virtually to introduce themselves; and consequently he knew very few managers indeed in the Eastern Counties. At the same time, he failed to see any utility in joining The Gas Institute. He thought it was a long way to their meetings; while, with a local Association, they could go to some of the neighbouring towns, and compare notes with their fellow-managers. As far as he was concerned, he should say by all means have an Association for the Eastern Counties.

The Secretary remarked that, ten years ago, he felt himself in a similar position to those who had already spoken. At that time he went to his friend Mr. Stout, and asked him whether they could not start an Association for the Eastern Counties, as he found them

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in all parts of the country. Mr. Stout, however, felt that at his time of life he could not embark in anything of the kind; and he referred him (the Secretary) to Mr. G. E. Stevenson, then of Peterborough. For some cause or other, he did not put himself in communication with Mr. Stevenson. He had felt a difficulty himself in not being able to meet his fellow-managers. If they would allow him, he should have pleasure in proposing that they form themselves into an Association comprising the districts he had already named. He thought they would be able to "paddle along," and in a short time get several more members. Mr. White, of Sherborne, told him that, when they started the South-West of England Association, they only had 18 members; and in their (the Eastern Counties) case they had a larger guarantee. If they decided to start the Association, he had drawn up some rules for consideration. They were on the lines of the Midland Association rules, which he considered the best; excluding as they did a good deal of the outside world—such as traders and others. He had pleasure in proposing that an Association should be formed.

Mr. T. GREAVES (Melton Mowbray) seconded the proposition.

Mr. J. CARTER (Lincoln) considered that the amount of support which had already been promised to the projected Association was quite sufficient to warrant them in laying the foundation of what he hoped would be a considerable structure before very long. In his own mind, he did not agree with those who had any idea of withdrawing sympathy or support from what had been referred to as the parent body of gas managers. He thought there was plenty of room for one central body and for District Associations as well. It seemed to him very essential that they should continue their support to The Gas Institute, because it was important that there should be some thoroughly general representative body to speak with authority upon gas matters. At the same time, there were undoubtedly local circumstances which they felt more or less weighty, and which could be more thoroughly discussed by a body of gentlemen who themselves had to manage works situated within certain localities. They would find an Association extremely useful. They were all concerned in the management of the same business; and their deliberations and their visits to one another's works would, no doubt, do something to improve and perfect their education.

The proposition was then carried unanimously.

RULES.

The CHAIRMAN said that, having decided to form an Association, the Secretary would read the rules which he had drawn up.

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The SECRETARY having read the rules he had prepared, they were discussed *seriatim*, and certain modifications were made.

THE FIRST MEMBERS.

On the motion of Mr. F. WELLER (Southtown, Yarmouth), it was decided to enrol as members all the gentlemen who had promised to support the Association.

ELECTION OF OFFICE-BEARERS.

Mr. GREAVES proposed that the Chairman that day should be elected the first President of the Association. He did not think they could have a better man.

Mr. BARTON thought that Mr. Barratt would make a good President, as he had had a great deal of experience.

The motion was carried *nem. con.*

The PRESIDENT briefly acknowledged the honour conferred upon him, and assured the members that he would do the best he could during his term of office.

On the motion of Mr. WIMHURST, seconded by Mr. CARTER, Mr. Barton was elected Vice-President.

Mr. CARTER moved the appointment of Mr. Wimhurst as Secretary and Treasurer.

Mr. HEYDON seconded the motion, which was carried.

Messrs. Best, Carter, Greaves, and Heydon were next elected to serve as the Committee; and Messrs. Weller and Yorston were appointed to the position of Auditors.

PLACE OF FIRST GENERAL MEETING.

The PRESIDENT suggested that Grantham should be the place of the first general meeting; and thereupon

The SECRETARY proposed that the first general meeting should be held, on the third Wednesday in March, 1889, at Grantham.

Mr. WELLER seconded the proposition, which was carried.

PAPERS.

The SECRETARY observed that they would require one or two good papers for the meeting.

Mr. CARTER remarked that he very much favoured the idea advanced in the current issue of the *Journal of Gas Lighting* [Sept. 25, p. 540]—that it should not be a *sine quâ non* that there should be papers. He considered that free-and-easy discussions upon matters of interest to all the members would do them more good than long papers.

Mr. GREAVES concurred in Mr. Carter's remarks.

Mr. WIMHURST said that at all events they would have the Inaugural Address by the President at the next meeting.

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Votes of Thanks.

Mr. Carter moved that a vote of thanks be given to Mr. Wimhurst for the patient labour he had bestowed on the formation of the Association; as well as to the President for presiding, and to Mr. Barton.

Mr. Yorston seconded the motion, which was confirmed.

The proceedings were then brought to a close.

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NORTH OF ENGLAND DISTRICT ASSOCIATION.

HALF-YEARLY MEETING, OCT. 12.

This Meeting was held in the Offices of the West Hartlepool Gas and Water Company—Mr. T. Bower, Engineer of the Company (the President), in the chair.

The Honorary Secretary (Mr. W. Hardie, of Newcastle-upon-Tyne) having opened the proceedings by reading the notice convening the meeting,

Mr. Fisher, the Chairman of the Hartlepool Gas and Water Company, in a few words of welcome addressed to the members, said that on the occasion of their previous visit, about seven years ago, they selected for their President their much respected and esteemed friend Mr. Trewhitt, the Secretary of the Company; and there was associated with him one who had passed away—his lamented friend Mr. Mossman, the Engineer. He was very pleased to find they had this year done honour to their Engineer (Mr. T. Bower), by selecting him as their President. Mr. Bower was one who, although comparatively new to the district, had already won "golden opinions." He alluded to the growth of West Hartlepool, and remarked that, as a matter of course, the gas-works were a great deal larger than they were when the members last saw them. The two were very much bound up with each other. Prosperity to the town meant prosperity to the Company; and *vice versâ*.

New Members.

The following gentlemen were admitted to the Association:—As Members: Mr. Herbert Lees, of the Workington Gas-Works; and Mr. E. W. Smith, of the Cockermouth Gas-Works. As Associates: Mr. W. Frazer, of Messrs. Frazer and Son, of Newcastle; and Mr. E. F. Wallace, of the Trimdon Colliery.

The President then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—I thank you most heartily for the honour you did me, at your last meeting, in electing me your President for the ensuing year. I have some doubts as to being able to fulfil the

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duties of the office in the manner they demand; and, while fully sensible of the great compliment you have paid me in placing me in this position, I am also deeply impressed with the duties and responsibilities of the office, following as I do the worthy men who have occupied this chair before me. I shall, however, endeavour, with your assistance, to carry out the objects of our Association; and I trust that, if we are not able at the expiration of my term of office to report much progress, we may at least have witnessed no retrogression. I trust, too, that each member will avail himself of that interchange of opinion and practical knowledge which is a chief feature of our meetings, by bringing forward, either by means of a paper or discussion, any subject that may be of interest to the members, or of service in the further development of the business with which we are all associated. I would especially ask this of the younger members of our profession, who will find that they are not only benefiting their fellow-members by imparting to them their experience, but that they themselves obtain much information in the discussion arising thereon that could not possibly be procured by a position of isolation.

We may fairly congratulate ourselves on the progress of the gas industry during the past year. Increased consumption has taken place in most towns throughout the country; and this fact is all the more encouraging when we consider the number of rivals which gas has to face, and the great competition that now exists both in public and private lighting. I am of opinion that the present year will be even more prosperous than the past; and so far as the North of England is concerned, I believe we are entering upon a term of trade prosperity, when considerably more gas will be required both for domestic and commercial purposes. Although the gas undertakings in charge of the members of this Association at present represent a capital of nearly five millions sterling, making 7200 million cubic feet of gas, and using over 710,000 tons of coal annually, I have no doubt that, as a greater demand arises, the necessary capital to meet it will be readily provided by the public, in whose favour gas stock seems to become more popular year by year as an investment.

Of late years much has been said of the electric light as a competitor with gas. I do not now intend to say much on this matter, further than this—that I think any diminished consumption of gas due to the introduction of such light has been fully compensated for by the increased consumption that has taken place through the public now having a desire for more light than they had prior to the introduction of the electric light; and while admitting that there are special purposes for which the latter light may be more

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suitable than gas, I feel sure that, for general lighting, gas has a bright future, and will long maintain the premier position it now holds. While, however, putting aside any fear of diminished gas consumption through the introduction of the electric light, I am not insensible to the fact that in paraffin oil we have a competitor that is likely to some extent to interfere with increased consumption. More especially will this be the case in small towns, and towns where the population is of a migratory character. I feel convinced that, unless the greatest facilities be given to the working classes to encourage the consumption of gas, that the use of oil, should it remain at its present value, will still further extend. And not only for domestic lighting will this be the case, but also for manufactories —such as iron, engineering, shipbuilding, and other large works, where of late the Lucigen light has been much used; it having in many instances in the North of England been substituted both for gas and the electric light. I think, however, that a great deal of the increased lighting by oil is due solely to the very low price of this commodity—a state of things resulting from the recent discoveries of such enormous and almost unlimited quantities of oil, the better facilities for its shipment to this country by the adoption of special tank steamers in preference to the usual system of shipping by barrels, and the keen competition that has arisen between the Russian and American petroleum districts. But although its cost is so very low, the disadvantages and risks attending its use are, as you know, very great; and almost every day this fact is prominently brought before us by the frequent occurrence of deaths from burning caused by the upsetting of petroleum lamps. There is besides the constant trimming of such lamps, the breaking of chimneys, &c. (which is a very great annoyance compared to the simple turning of the ever-ready gas-tap), to say nothing of the constant obnoxious smell arising from its use. All these points considered, I am of opinion that, if gas companies still continue to supply gas at the lowest possible price, diffuse a knowledge amongst the public of the conditions under which gas may best be consumed, and offer every inducement for its economical consumption, even the competition from cheap oil may be overcome, and the day is far distant when gas lighting will be materially affected by any of its competitors.

For purposes of cooking, heating, and motive power, much may yet be done to extend the use of gas; and we ought not to rest content until we can report that our customers for these purposes are quite as numerous as those for lighting. I look forward with hope that the day is not far distant when, not only cooking and heating stoves will be established things in all well-regulated

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households, but that small gas-motors will become general, both for domestic and trade requirements, and that the consumption of gas for such purposes will become as great as, if not greater than that for lighting. Without, however, waiting for such use of gas to develope itself in the course of events, gas companies should provide all possible facilities that will tend to urge on its speedy introduction. Let the public know and see the advantages to be gained by using gas for these purposes, and provide apparatus of the best kind either on hire or purchase. Especially would I recommend the hire system as one that ought to be adopted by all companies and corporations who have not yet introduced it; and should it still be necessary to advance any argument in favour of taking this step, I would point to the great success that has attended its introduction in almost every case—our own being no exception to this rule. Some sixteen months ago an exhibition of gas apparatus was held; and since then upwards of 300 stoves of all descriptions have been fixed—resulting in an increase to our business for this purpose alone of something like 6 or 7 per cent. on our total make of last year.

In the introduction of gas-engines, I am not sure that gas companies themselves have done all they might to extend their use; for, notwithstanding the fact that in the smaller sizes they have been proved both convenient and economical, we find in many gas-works that steam is still employed in preference to gas. This ought not to be the case, as the public very justly look to us for example. Gas-engines are, however, daily becoming more popular; and there are now some 28,000 of the "Otto" type alone in use. In several towns as many as one per 1000 of the population is in use; and when the advantage in the saving of boiler space, attendant's wages, diminished nuisance from smoke, and all the minor nuisances from steam, are considered, these alone are points of sufficient importance to recommend their employment. But even in the working cost, gas-engines with a consumption for many purposes not exceeding 20 to 25 cubic feet of gas per indicated horse power per hour will be found more economical than the cost of working many steam-engines, some of which were found by Sir Frederick Bramwell, in his recent tests at Birmingham, to be consuming as high as 20 lbs. of coal per indicated horse power per hour. I know this is a very high estimate, compared with the splendid results that have been attained by many noted makers of modern steam-engines on a large scale. But in small engines of more recent make, and such as are used for light trade purposes, it is no unfrequent occurrence to find the consumption of coal per horse power even much in excess of what I have already stated; and in these cases, in addition

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to the convenience before mentioned, gas-engines will be found a very economical substitute for steam.

Although the fall in the value of residual products during the past few years has been so rapid, and resulted in greatly diminished revenues to gas companies from this source, it is from a consumer's point of view matter for congratulation that, in very few cases indeed, have companies thought it necessary to increase the price of gas; such reduced receipts having been met either by the gas companies drawing upon their reserve fund, where any existed, or being content where none did exist to declare smaller dividends. This is a point that ought not to be overlooked by the public, should the value of residual products so far recover as to admit of better dividends.

Throughout the past year the value of tar and its products has shown considerable improvement, and will, I believe, still continue in an upward direction. Quite recently an offer was made to one of the largest chemical manufacturing firms in the kingdom, to purchase the whole of the tar products produced at their works during the year 1889 at present market prices; and although there may be an element of speculation in such an offer, yet to some extent it indicates that the parties most intimately connected with the business have confidence in existing prices being maintained. I trust, however, that both buyers and sellers will abstain from making long forward contracts on what may seem favourable terms; as, however pleasant it may be for companies to receive for the time being prices for their tar far in excess of its market value, such a condition of things cannot tend to cultivate a healthy state of trade, as it must be equally unpleasant, as well as disastrous, to chemical manufacturers to have to pay for tar a price far in excess of what its products will realize.

Sulphate of ammonia, which commenced the year at £12 10s. per ton, has continued to average a little under that price down to last week's quotation of £11 10s. per ton; and at this figure the market is very firm. As the manufacture of sulphate becomes more general among gas companies, I should anticipate that a greater demand for it will arise, as each company will, I feel sure, use all possible means of bringing before farmers, in their own immediate district, the value of sulphate of ammonia as a fertilizing agent, and thereby create a better local demand. Farmers, too, in these days of better technical and scientific education, should not be slow to avail themselves of such facilities, as in purchasing sulphate direct from the producers they will be far more likely to get full value for their money than by the purchase in the open market of manures that are not always free from deleterious

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substances, and in very many cases do not contain the proportion of ammonia stated by agents anxious to effect sales; whereas, on the other hand, gas companies will desire to secure local reputation, and will at least see that the farmer gets what he bargains for.

Plant for working on the continuous, in preference to the intermittent system is now being generally adopted, as tending not only to reduce the cost of producing sulphate, but also to deal with much larger quantities of ammoniacal liquor in a given time. The elimination of the sulphur from the waste gases arising from such manufacture has of late received much attention, with the result that the Claus patent sulphur-recovery plant is becoming much more used. This, I think, is a step in the right direction, as, even if the plant is not found very profitable, it will convert into a commercial commodity what has hitherto caused more or less nuisance. On this ground alone, it is worth our consideration; as every effort should be used to carry on our business with as little annoyance to others as possible. Later on you will have an opportunity of seeing a new sulphate plant, on the continuous process, recently put down for my Company by Messrs. R. and J. Dempster, and in conjunction therewith one of the Claus sulphur-recovery plants erected by Messrs. C. and W. Walker. In consequence of the short period they have been at work I am unable now to give many particulars of the cost of working, but may at some future time have the pleasure of placing before you the results of a more lengthened experience.

The demand for gas coke has of late been very brisk, resulting in most of the old stocks being cleared out, and better prices realized. This demand I attribute partly to a revival in the home trade, causing a larger consumption, and partly to the increased quantity that has recently been sought after for export. Both for domestic and trade purposes, coke ought to be much more extensively used, were its advantages thoroughly understood and appreciated by the public. It is not generally known, I believe, by the owners of small steam-boilers that, by the use of coke under such boilers, steam can be raised quicker than by coal, and in many cases at much less cost. For smiths' purposes, too, it has been found very serviceable; and in a large number of shops is now almost exclusively used in place of coal. The extended use of coke would also tend to assist in solving the vexed question of smoke abatement, and reduce the enormous loss resulting from the dense volumes of smoke which now issue from the chimney stack, besides clearing the atmosphere of such smoke, and thereby assisting to make life more pleasant in our populous towns.

A movement has recently been started here in the north by the

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Worshipful Company of Plumbers, to establish local centres for the registration of plumbers. This is a movement that should in all towns receive the hearty co-operation and support of gas managers and gas companies. It is unnecessary for me here to dilate upon the many annoyances that gas consumers have to put up with through defective plumbing; and any steps that will tend to place plumbers' work on a more scientific basis will, I feel confident, be accepted as a great boon by the general public, who must necessarily have greater confidence in the work executed by registered plumbers, who are known to be men of ability for their work, than in the work done by indifferent workmen who are not registered. To plumbers themselves, this system will be very advantageous, as it will ensure competent men only being sent out to first-class work at better wages; thus giving to those who have served a proper apprenticeship, and who, by careful attention to their work, have thoroughly mastered the details thereof, better remuneration for their labour than the careless and indifferent workmen whose labour in this particular branch is too often found to be dear at any price.

I am afraid, however, that many of the annoyances gas consumers have to contend with are not due altogether to careless plumbing, but in many cases may be traced to consumers themselves, who will persist in purchasing the cheapest of everything they can find connected with gas lighting—articles that in the end often cost very much more than those of a better class, to say nothing of the constant annoyance arising from the use of such fittings. One of the aims of the Plumbers' Company is to endeavour, in the erection of new houses, to prevail upon the builders and architects thereof to omit the plumbing work altogether from their specifications, and to set apart such a sum as will enable this to be done in a satisfactory manner by registered plumbers, at such rates as may be found remunerative for better-class work; thereby avoiding to some extent the great competition that now exists in plumbing, and the scamped work arising from such competition and low prices. It will be necessary in doing this that some schedule of prices shall be adopted for the different classes of work to be carried out. But it also occurs to me that, before such a system could be satisfactorily adopted, it would in the case of gas and water fittings be necessary also to have a schedule of standard sizes, which all registered plumbers must be compelled to work to; and although this system is already in existence in some towns, it must, to ensure success, and its universal adoption, be enforced by some legal and acknowledged authority, such as parliamentary power, or else, failing that, instructions from a Joint

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Committee composed of members of the Plumbers' Company, who would have control of all registered plumbers, and members of The Gas Institute acting on behalf the gas companies throughout the country.

Referring as I have done to the necessity of standard sizes being adopted in gas-fitting, leads me for a short time to the consideration of the adoption of this system to gas plant generally—a subject which, to my mind, deserves more attention than it has hitherto received either from gas managers or the makers of gas apparatus. Some time since Mr. Whyte, of Seaham Harbour, brought this matter before our Association.* Although in his paper he dealt chiefly with retorts, I am of opinion that the principle may be extended to most apparatus connected with gas-works with very considerable advantage to both makers and users of such; and I feel quite sure that this fact will be admitted by all who know the great benefit arising from the adoption of Whitworth standard sizes of threads, and standard sizes for meters, &c. There is perhaps no part of the apparatus employed in gas making which permits of greater scope for reform in this direction than retorts and retort-fittings. To describe all the different sizes and shapes of those in use would be a work far too tedious for this meeting, and one that I shall not attempt; but I would ask how often do we find, in works of only moderate size, three, four, or more different sizes and shapes of retorts in use on one bench, separate patterns for all of which have had to be made—thereby incurring additional expenses, which must be borne by the users of these articles, either directly or indirectly, to say nothing of the confusion that arises through so many different patterns being in use. Take, for instance, the Ω-shaped retort—a form that is very extensively used—it will be found that almost every engineer has some particular preference both in size and shape. It is surprising the number of different shapes that are in use of this form of retort of even the same size. Some have sharp square corners; others are a little round; while in other cases they are so round that it is difficult to distinguish them from ovals. Then, again, in some the top part will vary; while others differ in the number of bolt-holes. If all these shapes be made in six, eight, or as many as ten different sizes, you would readily see that the cost incurred therein must be enormous; and the matter becomes one of greater importance than we are apt to attach to it.

Many manufacturers have given it as their opinion that, were standard sizes adopted, a saving of at least 10 per cent. might be effected; while in retort-fittings almost as great a saving might

* See "Reports of Gas Associations" for 1887, p. 247.

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also be made. And this is not the only advantage we should gain by the adoption of standard sizes. Many, if not all of us, have at one time or another suffered some inconvenience and annoyance through delay in the delivery of retorts at a time of the year when makers have been pushed to execute in a short time more orders than they were able to do; and some of us also remember having had retorts sent that had been taken from the kiln long before they were sufficiently well burned. This might to a great extent be overcome if makers knew the sizes likely to be required, and could put into stock a number of each size, which could be made at a time of the year when they had few, if any, orders in hand, to be kept until the busy season, or for cases of emergency arising from accidents or other causes, when they would be ready for despatch at once. Then for purposes of comparison of the make of gas per mouthpiece at different works, how much more simple it would be were standard sizes universal!

In the case of valves, how seldom do we find two makers having the same size of flange, or having the same centres for bolt-holes. Again, in flange-pipes the same thing occurs, often resulting not only in extra cost for patterns, but in considerable delay to get special sizes; whereas in standard sizes they might often be kept in stock and ready for use at once. There are many other advantages I could name in favour of the system I advocate, all of which point in one direction—viz., a considerable saving in cost, as well as the great convenience arising therefrom to both makers and users. But I think I have said sufficient to justify some steps being taken to bring about this change in gas apparatus. I am aware that many difficulties and prejudices would arise before such a change could be brought about; but I am also of opinion that, with hearty co-operation on the part of makers (which I feel sure will be readily given), all such difficulties might be overcome, and a recognized standard of sizes adopted, which, while giving sufficient scope for improvement and *bonâ fide* progress, would reduce the cost of apparatus, and tend to still further cheapen the cost of gas. I would suggest that the consideration of this subject is of sufficient importance to be relegated to a Special Committee, composed of members from all the District Associations, to collect information and report thereon as to the practicability or otherwise of its adoption; and I feel sure much good would result from the labours of such a Committee.

The better technical education of young men about to enter the gas profession, is a question that has of late received much attention; and some good suggestions on this subject have been offered by our older members, which will no doubt prove serviceable,

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as well as tend to direct more particularly the attention of young men to the great necessity for them to give this matter the most careful attention, as it must be patent to all that those who in the future combine scientific attainments with practical experience are those most likely to come to the front. The spread of scientific and technical education should lead to the introduction of new and improved appliances for both the manufacture and distribution of gas, and with it will also arise the question of how best to stimulate and encourage the use of such improved appliances. It is well known that the preliminary expenses necessary to be incurred in experimenting with new apparatus, previous to its introduction to the public, often deters the adoption and proper working out of new inventions, which might otherwise be of much value; and until some scheme of dealing with such matters—either by means of Research Committees appointed by The Gas Institute, or otherwise—is determined upon, I would strongly urge upon directors of gas companies and gas committees to allow their managers every reasonable facility and help to work out any new idea that may be likely to benefit not only themselves, but the industry generally.

The question of gasholder construction is one that is just now receiving much attention; and should the experiments recently made by Mr. Livesey still continue to prove successful, and the views of Mr. Gadd be brought into satisfactory practice, we are likely soon to witness great changes in the method of construction of this part of our apparatus, which will tend to lessen a cost that is now one of the chief factors in our capital charge.* I hear, too, that our friend Mr. Ashmore, whose long experience in gasholder construction well fits him for such a duty, is perfecting some scheme with a view to this end. As we are to have a paper today upon gasholders, however, I will not at present say more on this subject.

In conclusion, I would add a few words with reference to the resignation of members of the Council of The Gas Institute which has taken place since our last meeting. I am forcibly reminded of what Mr. Newbigging in his address seemed to foreshadow, when presiding over the twenty-first annual meeting at Manchester—viz., that the meeting then being held might perhaps mark a crisis in its history. It would almost seem that such was to be the case; and if the Institute is to be of that service to the members in the future that it has been in the past, it will be

* Mr. Livesey's experiment at Rotherhithe was described in the *Journal of Gas Lighting* for July 31, 1883 (p. 199); and Mr. Gadd's arrangement is explained and illustrated in the paper read by Mr. T. Newbigging before the Manchester District Institution of Gas Engineers (see *ante*, p. 243)

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necessary that the greatest care and judgment should be exercised in future proceedings. In Mr. Woodall, the President, we have a gentleman likely to command the confidence of a great majority of the members, whose hearty support I have no doubt will be given him in any scheme of reorganization he may submit. I would point out how desirable it is, in the vacancies that have to be filled up, that gentlemen from all parts of the kingdom should be elected, and not too many from any particular locality; as by this means the whole of the members would be brought into closer contact with the Council, through their representation thereon. I would suggest, as a step in this direction, and in order also that the District Associations may become more in touch with the Parent Association, that the President for the time being of all District Associations should be a member of the Council.

The PRESIDENT then called upon Mr. J. Wright, of Stockton-on-Tees, to read a paper on "Modern Methods of Increasing Gasholder Storeage;" saying that it was at his (Mr. Bower's) special request that Mr. Wright had kindly consented to contribute this paper. It had occurred to him that it might be desirable to have a paper on this subject, following up the remarks upon gasholder construction which they had from their President last year.

Mr. WRIGHT then read his paper, as follows:—

MODERN METHODS OF INCREASING GASHOLDER STOREAGE.

There cannot be two opinions among people engaged in gas manufacture or gas engineering as to the absolute necessity of finding out the cheapest and best methods, either of laying down new gas-works or carrying out extensions of old ones. More especially is this necessary when looking at the competing interests which gas meets at every turn. These interests are so palpable to everyone here present, that it is unnecessary and almost unwise to particularize them. Hence it is, Sir, that, when I received your invitation to prepare a paper specially for this meeting, I responded with some alacrity; feeling sure that on the subject of "Modern Methods of Increasing Gasholder Storeage," I could indicate a course, and supply figures which, I trust, will be of interest to those engineers who are hampered in that direction.

A modern gas-works is so much a centre of "Light and Leading" that no matter how rural a site is chosen for its location, you no sooner see it established, than the speculative builder puts in an appearance; and in a very short time, the works are closely environed by streets of houses and their usual accompaniment—a dense population; making any extensions of site very costly and

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well-nigh impossible, owing to considerations connected with the outlay of capital.

Gasholders are a trouble to many gas managers. They take up so much space, there is so much risk in the construction of new tanks, and opinions differ so widely now as to what is or is not an absolute necessity for the construction of the gasholders both inside and outside, that it is putting it mildly to say that to the ordinary gas manufacturer, they are an unsolved problem. In a short paper of this description it is impossible to go into the *pros* and *cons* of either the old system of gasholder construction or of all the "fads" that are now bulking so largely before the gas world. It is a still greater impossibility to attempt to give any rules or descriptions of gasholders which would make them and their treatment more familiar to the average gas manager. I must, therefore, content myself with taking one specific branch of gas engineering—viz., that of doubling or trebling existing holders, and indicate what has been done to relieve pressing cases for increased storeage, without having to go into questions connected with extension of site, re-arrangement of mains, &c.

It is desired to make this paper of interest and profit to all members of this Association, whether they are interested in large or small concerns; and I have therefore made the tables of dimensions and costs (Nos. 1 and 2) sufficiently extensive to meet the cases of small and large works. These are the central points of my paper, and are before you.

TABLE I.—*New Holders and Tanks.*

No.	Capacity Required.	Diameter of Tank.	Cost of Tank.	Cost per 1000 feet Capacity of Holder.	Diameter, Depth, and Description of Holder.	Cost of Holder.	Cost per 1000 feet Capacity.	Total of Tank and Holder.	Total Cost per 1000 feet Capacity.
	Cubic Feet	Feet	£	£	Feet	£	£	£	£
1	55,000	62	900	16·36	60 × 20 Single	750	13·64	1650	30·00
2	75,000	72	1200	16·00	70 × 20 ,,	900	12·00	2100	28·00
3	110,000	62	900	8·18	60 × 20 Two-lift	1000	9·09	1900	17·28
4	150,000	72	1200	8·00	70 × 20 ,,	1350	9·00	2550	17·00
5	200,000	82	1400	7·00	80 × 20 ,,	1900	9·50	3300	16·50
6	250,000	82	1650	6·60	80 × 25 ,,	2100	8·40	3750	15·00
7	300,000	92	1800	6·00	90 × 24 ,,	2500	8·33	4300	14·33
8	400,000	102	2250	5·62	100 × 26 ,,	3000	7·50	5250	13·12
9	500,000	122	2500	5·00	120 × 24 ,,	3500	7·00	6000	12·00
10	750,000	122	2500	3·30	120 × 24 Three-lift	5250	7·00	7750	10·30
11	1,000,000	143	3000	3·00	140 × 24 ,,	6500	6·50	9500	9·50

Table I. gives the average dimensions, capacities, and costs of ordinary brick or concrete tanks, together with their gasholders of ordinary construction. I do not propose to try your patience by

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reading through all the figures of either of the tables, but may explain that, taking case No. 1 in Table I., where it is supposed that additional storeage is required for 55,000 cubic feet, this is represented by a single-lift gasholder 60 feet diameter by 20 feet deep. The diameter of the tank to contain the holder is given in the second column. The cost, exclusive of mains, in the third. Then we have in the fourth column the cost of the tank per 1000 feet of additional capacity gained. Then, in the order named, you have the dimensions of the gasholder; cost of ditto; cost per 1000 feet of storeage gained; total cost of tank and holder; and in the last column the total cost for combined tank and holder per 1000 feet of storeage gained, which in this case, runs out to £30 per 1000 feet. You will please observe that I have not included the cost of land or of mains in any of my figures.

TABLE II.—*Cost of Doubling or Trebling Existing Holders.*

Reference Letter.	Capacity Required.	Approx. Dimensions of Holder added.	Cost of Telescoping.	Total Cost per 1000 feet gained.	Total cost per 1000 feet from Table I.	Saving per Cent.
	Cubic Feet.	Feet.	£	£	£	
A	55,000	60×20	650	11·80	30·00	60·75
B	75,000	70×20	865	11·50	28·00	59·00
C	110,000	80×22	1155	10·50	17·28	39·20
D	150,000	90×24	1250	10·00	17·00	41·18
E	200,000	100×27	1900	9·50	16·50	42·43
F	250,000	120×25	2250	9·00	15·00	40·00
G	300,000	130×24	2550	8·50	14·33	40·70
H	400,000	150×25	3200	8·00	13·12	39·00
J	500,000	150×30	3750	7·50	12·00	37·50
K	750,000	160×38	5250	7·00	10·30	32·00
L	1,000,000	180×40	6000	6·00	9·50	36·75

I will now suppose that you have built holders and tanks on every available yard of the gas-works; and it becomes a question with you how to get 55,000 cubic feet of storeage. Table II., example "A," shows what I call the cheapest way of accomplishing it—viz., by telescoping the gasholder. You have the capacity in the second column; dimension of holder in one lift to contain the gas in the third; the cost of telescoping in the fourth; and the total cost per 1000 feet in the fifth. Then, for the purposes of comparison, I bring the figures per 1000 cubic feet from the last column in Table I., and place them alongside the cost shown by Table II. for doubling or trebling; and the last column exhibits the enormous saving of 60·75 per cent. in favour of telescoping. This may be regarded as an extreme case, and it undoubtedly is; for it may be noted that, by using a small telescopic holder, and building a much smaller tank, considerable cost may be saved. I have not gone

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into this question, because very small telescopic holders are troublesome, and because the difference is clearly shown lower down the table. Take, for instance, case No. 3, where the required capacity is 110,000 cubic feet. The cheapest way to obtain this by a new tank and gasholder is to build a 62 feet tank, and put in it a two-lift holder 60 feet by 20 feet. By following through the figures, you will see that the increased capacity of the gasholder reduces the cost of the tank per 1000 cubic feet to £8·18 instead of £16·36; and the total combined cost of the tank and holder is reduced to £17·28 per 1000 cubic feet. The parallel case to this in Table II. is that indicated by the letter "C." To gain a capacity of 110,000 cubic feet by telescoping would need a single-lift 80 feet diameter by 22 feet, added to an existing one. This can be done, as shown by the table, at a cost of £10·5 per 1000 cubic feet, as against £17·28, or 39·20 per cent. in favour of telescoping.

		Cubic Feet.			Per Cent.
Case D in Table II.,		150,000	capacity shows a saving of		41·18
„ E	„	200,000	„	„	42·43
„ F	„	250,000	„	„	40·00
„ G	„	300,000	„	„	40·70
„ H	„	400,000	„	„	39·00
„ J	„	500,000	„	„	37·50
„ K	„	750,000	„	„	32·00
„ L	„	1,000,000	„	„	36·75

It ought to be added that example "C" represents the actual cost of a holder dealt with in this way. Case "F" is the average of six two-lift holders which were converted into three lifts for one corporation. Instance "G" is an average of four holders that were telescoped. Case "J" also represents the actual cost of a contract executed.

If any criticisms should be offered as to my figures being too high or too low, my reply is that the costs in Table II. are estimated on the same basis as Table I.; so that the differences are in the same ratio. Therefore, my deductions or percentages will be the same. The figures generally are based on the assumption that the first holders have been constructed with a view to telescoping. It is, however, to be feared that many holders have been erected without the necessity for their extension having been apparent at the time of their construction. In such cases as these, it will be necessary to put a new holder altogether inside the old one, by cutting away as much of the top sheets as is necessary, to make room for the new inner lift. This will probably increase the total cost, as given by Table II., by 10 or 15 per cent.; but my figures give sufficient margin to allow for this increase, and leave ample justification for what I will call a "telescoping policy."

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I must not, and do not, desire to ignore the difficulties that lie in the way of so many gas engineers in following the policy I have described. For instance, you may have only one gasholder, and may consider it unsafe (so to speak) to have all your "eggs in one basket." To a member so circumstanced, I would say: By all means build another holder and tank before adopting the policy indicated. Another may have a guide-framing to his holder unsuitable for extension, or possibly incapable of standing as it is; and the only resource here is to dispense with the old and substitute new. Columns which are now small can be raised up and supported on stronger bottom lengths. Columns or standards that are large can be lengthened out, and braced by a system of girders and diagonal bracing. If it is inconvenient to adopt any of these ideas, we must not forget the important experiment which has been tried by Mr. Geo. Livesey, at Rotherhithe, which points to the possibility of lengthening and increasing the capacity of gasholders without having to add to the columns or girders, where they are sufficiently strong. This will at once reduce the cost so as to make telescoping much more favourable than the figures shown in my tables.

It will, of course, be possible to effect still greater economies in telescoping gasholders, if the ideas which are now so much under consideration, of dispensing with guide-framing, are found to be practicable. As an item of interest in this connection, I may be permitted to state that my friend Mr. Ashmore some weeks before the Doncaster meeting of the Manchester District Institution of Gas Engineers and Managers, patented an idea which will be effective without even the complication of fixing spiral guides in the tank. For obvious reasons, we cannot here go into the details of one or the other invention, as they are foreign to the subject of this paper, and are only mentioned to remind you that further developments of the science of gasholder construction may, and no doubt will, enable you to telescope holders very much below the favourable figures I have now laid before you.

Discussion.

The PRESIDENT said they must all have been interested by Mr. Wright's paper; and, apart from the value that attached to the details which he had given, a very great point had been gained in the reading of the paper, by his placing on record statistics in connection with gasholder manufacture and the working out of the cost of their construction, which were only known to manufacturers themselves. This would, he thought, be of much service to gas managers who were considering the question of increasing

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their storeage. This was one of the main reasons why he invited Mr. Wright to read a paper upon this subject, because he felt that they had only individual cases recorded of the doubling or trebling of gasholders; whereas manufacturers like Messrs. Ashmore, Benson, Pease, and Co., who were constantly engaged on this sort of work, had details at hand which gas managers could not command, and which would be of much help. He trusted, therefore, that if any managers there were anticipating extensions, or would like to gather any information on the subject, they would not be slow to come forward in the discussion.

Mr. W. FORD (Stockton) observed that, before attempting to make any remarks upon Mr. Wright's paper, he might say that a gentleman was present who was much more accustomed to deal with actual manufacture than most of them; and he thought it would be interesting to hear what criticisms he might offer upon a paper like that, because they all knew that manufacturing firms who had leading men like Mr. Wright or Mr. Cripps, were very much more able to enter into details than ordinary gas managers, who were sometimes filled with hesitation on the subject.

The PRESIDENT remarked that he had intended to call upon Mr. Cripps, but thought it probable that a member of the Association would have spoken first.

Mr. F. S. CRIPPS (London) said he would offer a few remarks, but not by way of criticism on the paper. He agreed with Mr. Wright that, in the majority of cases, it was better to add a new lift to an existing gasholder than erect a new gasholder on another site. Of course, there were circumstances which governed individual cases. They could not say: "I have a gasholder; and I will add another lift to it," without first considering whether the guide-framing was sufficiently strong, or whether, on other grounds, it was advisable to do it. He could not then go into the various things which one had to consider; but he might say that, in most instances, it was best to add a lift. He also suggested that, in designing a gasholder in the first place, provision should be made for telescoping in the future—for converting it into either a double or a treble lift as the case might be. Of course, it was very difficult, with an old-fashioned gasholder, with rickety guide-framing perhaps, to add a new lift to it, because they would be cutting through the framing, and incurring an increased expenditure, which would not have been brought about if it had been considered in the first instance. Regarding the abolition of guide-framing altogether, this was such a big subject that he could not enter upon it; besides, Mr. Wright had not advanced it in his paper. He understood, however, that the Rotherhithe gasholder

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was working very favourably; and it was his opinion that, in the case of gasholders where the guide-framing was sufficiently strong as it stood, and the outer or lower lifts were very rigid, a new inner lift might be added without any danger. The Rotherhithe gasholder, they would say, proved it; but he believed a good deal of extra strengthening had to be made at the bottom before it was undertaken. He did not know that he could say anything else; but he would be very glad to answer any questions.

Mr. W. HARDIE (Newcastle-upon-Tyne) remarked that they had two gasholders at their Elswick works; and they had not room to put down another, so they telescoped the then existing ones. This was done two or three years ago; and the holders had worked very well. By telescoping these holders, they obtained extra storeage at a very moderate price; but Mr. Ridley would be better able to give information about it than he was.

Mr. G. RIDLEY (Newcastle-upon-Tyne) said the telescoping of the two holders was a very great acquisition to the Company; for the simple reason that it increased the storeage by one-third. Trebling gasholders he considered was the proper thing to do; and especially in the case of a growing town. When constructing a single-lift holder, why should they not make it a double one? They obtained a double or treble lift without the cost of an additional tank. All they required was the shell of the lift, and the cost of putting it in. They could easily see the immense gain of having a middle lift, without having to go to the expense of a tank or connections.

Mr. CRIPPS suggested that the question of pressure would have to be considered. If they put a new lift to a gasholder, they added to the weight; and this increased the back pressure. This caused extra expense; and it was worth consideration.

Mr. RIDLEY could not off-hand say that any additional expense was caused; for the simple reason that he kept a weekly record of the cost of manufacture, and he found that he could produce gas as cheap, or even cheaper, with extra pressure.

Mr. J. HEPWORTH (Carlisle) expressed the indebtedness of the members to Mr. Wright for the paper he had been good enough to read. He was very glad it was suggested to the author that he should tabulate the very interesting and valuable information which they saw in the tables now placed before them. The paper was mainly an argument for telescoping gasholders rather than erecting additional ones. He hoped the day was now past for any such argument to need very much enforcing. It was evident that, if there were no unfavourable circumstances, it must be much better, and considerably cheaper, to telescope a gasholder,

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by putting in a second or a third lift, than it would be to go in for a new holder. The only point worth considering was, he thought, how far it might be safe to do this; and some of them, though a long way off from Rotherhithe, had been watching with much interest the experiments in that direction which had been carried out there. So far as the figures in Mr. Wright's paper referred to it, and so far as the information which he possessed otherwise went, the experiments seemed to have been very satisfactory indeed. Everyone who had to do with the designing of gasholders in these days, should be wise enough to prepare for the telescoping of the holders in the future. The cost of the tank was the same; and the expense of preparing to telescope the holder (say) ten years hence was very little. It therefore appeared to him to be almost folly to construct a gasholder without keeping this matter in view. The last few years he had constructed several gasholders; and in every case he made provision for telescoping, in the interests of those who should come after him, either for the addition of a second or a third lift. Of course, this subject was not new. Everybody knew that it was cheaper to telescope a gasholder than to start *de novo;* but it had been forced upon their attention recently very much more than previously by what had been done at Rotherhithe. With reference to the increase of pressure, there was no doubt that some extra cost was entailed; but this would be found to consist very largely, he should think, in the first outlay for the exhausters and the other plant necessary for overcoming the pressure. The actual working cost would be very little indeed.

Mr. C. SELLERS (York) said he was in the very happy position which had been referred to, of not needing to prepare for any increased storeage of gas. They were pretty well provided for a considerable time. He had been much interested in the discussion, and felt that he could not add anything to it. He thought the case was clearly and strongly made out in favour of the proposition of Mr. Wright, to provide increased storeage capacity by means of the telescopic principle; and all the arguments, he thought, in favour of it had been so clearly put before them, that he should say there would not be two opinions regarding what had been said for that principle. Especially, he thought, they would all agree with the prudence pointed out first by Mr. Ridley, and then made very clear by Mr. Hepworth, of providing for the future extension of the holder when first building. In doing this, the cost was, of course, a very strong argument; and the fact of Mr. Wright bringing the principle prominently before them that day would fix it in their minds, and he was sure everyone would reap considerable

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advantage from the paper. It was not a very debatable subject; but they would all be greatly benefited by the paper.

The PRESIDENT remarked that they had with them a prominent member of the Manchester District Institution of Gas Engineers —Mr. Booth, of Southport—who perhaps would like to make a few remarks on the subject before them. He (the President) might mention that Mr. Gadd, who had recently figured very prominently in this matter, was a resident in Manchester, and probably Mr. Booth might tell them something which had been stated at the Manchester meeting.

Mr. BOOTH said that unfortunately he was prevented from attending the meeting of the Manchester Institution when Mr. Newbigging described Mr. Gadd's invention and the models were exhibited. He regretted this very much indeed. With regard to the paper read by Mr. Wright, he might say that he heartily agreed with previous speakers. He thought that, as a rule, it was decidedly the best way of increasing gasholder storeage. He was surprised to find that morning, on looking round the Stockton Gas-Works, that his friend Mr. Ford had put a third lift to his holder. He was not aware of this before. Mr. Ford, as they knew, was conservative in many things; but he (Mr. Booth) was glad to see that he had stepped out, and had not been afraid to advance in that line. He himself would soon have to increase the capacity of his holders; but whether or not he could adopt the principle advocated by Mr. Wright and other engineers, he was not sure. It happened that they could not carry their tanks below the ground, as they met with quicksand when they got about two or three feet down. All their tanks were constructed above ground, so that with the tank alone they were 30 feet above the datum line, and the gasholder was towering up to a very great height. It would, therefore, be a matter for him to consider, in any future extension of gasholder storeage at Southport, whether he should put up a third lift to his existing holders. As he had already stated, he concurred with all that Mr. Wright had said, and agreed with previous speakers.

The PRESIDENT, before asking Mr. Wright to reply to the criticisms which had been passed, said he would like to state that in the case of his Company additional storeage was a matter which would shortly engage their attention. He had been down to Stockton to see what their friend Mr. Ford had done before commencing anything in their own case. He was rather afraid they were not placed in a similar position at all to Mr. Ford, who had two or three gasholders in addition to a large one. With them their large holder was practically *the* holder. They had another

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a small one, but it would not be of very much service if the large one were thrown out of use for a considerable time. So he was afraid that in their own case the trebling of the gasholder would not be of much benefit to them at present. As Mr. Wright had said, it was not desirable for them to "have all their eggs in one basket;" and he thought that in their particular case they should almost be driven to the necessity of providing another gasholder. But he certainly thought that the advantages to be derived from doubling or even trebling were so great that, in all cases where it could be done—if there were no circumstances to prevent it—they ought to adopt this plan. He saw a short time since that either four or six holders had been trebled at Bradford. There they obtained a considerable increase of storeage at a great saving of cost; and had they not been able to get this increase without additional land being required for tanks, it might have been a very costly matter to obtain parliamentary powers for the acquisition of additional land. For a few years, at all events, this had been staved off by trebling their gasholders. As he had already said, they were all very much indebted to Mr. Wright for the valuable records he had placed before them. He (the President) knew very well that the members would give him their hearty thanks for his paper; and he would ask some one to propose a vote after Mr. Wright had replied.

Mr. WRIGHT said the remarks which had been made on his paper had been extremely kind; and he had really nothing to which to reply. Any criticisms passed had been answered by members who had taken part in the discussion. He could only thank the meeting for the kind reception they had given him.

Mr. FORD said he had great pleasure in proposing a hearty vote of thanks to Mr. Wright. He had not taken any part in the discussion, because he felt that he could not have done justice to Mr. Wright's paper. If they had had the figures before them, and been able to digest them a little, they might have come forward with something satisfactory; and he should have been delighted to enter upon the subject from his own point of view. There was no doubt that he had successfully trebled a large gasholder, which had worked for three years in a way that was quite satisfactory to him. Unfortunately, it was not in the first instance arranged for trebling; and they had to put in operation the process of cutting and carving to some extent before getting in the third lift. But, with all the trouble and inconvenience attached thereto, they obtained an addition at a very moderate cost, which they would not have done by placing another tank alongside the existing one. Trebling a holder, he knew, was somewhat difficult;

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and he was glad to hear Mr. Cripps make the statement he did. He could not agree with Mr. Ridley that pressure was of no account. He had always found that pressure was of importance in a gas-works. Without going into the matter so as to lay it before them, as he might do some day, he must say that he had felt it to be a drawback, but nothing to correspond with the advantage to be gained by the trebling of a holder. Therefore he agreed with Mr. Wright's theory, and was at one with Mr. Hepworth in thinking that when holders were first built they should make preparation for trebling them. Since Mr. Wright came amongst them 16 or 17 years ago, he had been a friend to all gas managers, inasmuch as he was able to save them from much heartburning by giving them information which they could not otherwise obtain. Mr. Wright was always ready to help in every way.

Mr. R. Bridge (Doncaster), in seconding the proposition, said they would all be much benefited by Mr. Wright's valuable paper. It was quite clear to him (Mr. Bridge), and it appeared to be so generally, from the way in which the matter had been received by the members, that telescoping was a very cheap form of increasing storeage capacity, more especially in crowded localities. In his own case, he had a gasholder of very large diameter, but very shallow. It had been prepared for telescoping; and he had no doubt that the principle advocated by Mr. Wright might be applied to it. He did not know what was to be the future of gasholder construction. He had had the pleasure of seeing Mr. Gadd's models, and they certainly appeared to him to be a very great advance upon the present style of building these structures. If the thing could be carried out as they were assured by Mr. Gadd it could, it would be something like a revolution in gasholder making. However this might be, he was sure they were all much indebted to Mr. Wright for the paper he had brought before them.

The motion was carried unanimously.

Mr. Wright acknowledged the vote.

Mr. Ashmore remarked that he had recently taken out a patent for telescoping—doubling or trebling—gasholders; and he hoped at the next meeting to read a paper on the subject, and perhaps submit a model for erecting holders without framing at all.

M. Perret's Dust-Fuel Furnace.

Mr. C. Sellers (York) said it occurred to him that he might perhaps make a suggestion in regard to M. Perret's dust furnace.* He did not know if anyone there had it in use; but about a month

* The furnace was described in the *Journal of Gas Lighting*, July 14, 1885.

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ago they had it fixed to one of their boilers at the York Gas-Works, and it had been of very great advantage. As they knew, he had always been much in favour of breaking coke, in preparing it either for domestic use or for slow-combustion stoves, which were now so common in all large towns; but there had been a drawback to the process, inasmuch as the breaking of coke created a certain amount of exceedingly small breeze, which was almost unsaleable —only fetching from 2s. to 2s. 6d. per ton. They were in the habit of riddling it, and getting perhaps 4s. per ton for a portion of it, to be used in greenhouse fires—a sort of nut coke. Perret's dust furnace would consume any combustible dust of any kind. It was so valuable in their case that, although it had been but a short time in use, from the calculations which he had made, he had no hesitation in saying they would get back the whole of their capital in the first year's use. They had taken a tender for two furnaces—one for each of their boilers; but they had only fixed one, as they intended to get a new boiler next year, when they would fix the second one. The result of the test of the first one was such that, as he had said, it would yield back to them the whole of the capital outlay in the first year—a capital of about £60, fixed complete. This was a suggestion which was worthy of the consideration of every gas manager; and it was on the lines of Mr. Wright's paper, and on lines of economy in gas management. Everything that tended to lessen cost in the conduct of gas-works was a decided advantage to gas companies, and also to gas managers, because the less capital they had to make profit to pay interest upon, the more easily they could do their work. It enabled them also to sell gas at a cheap rate; and the cheaper they sold gas, the safer would be their industry, and the more permanent would be gas investments. He had very great pleasure in submitting this matter for consideration; and he would be pleased to answer any question respecting the furnace.

Mr. J. Hepworth (Carlisle) observed that this sounded rather like an advertisement of the invention; but he had no hesitation in saying that, whatever benefit might accrue to the inventor, there would also be great benefit to the user. He had employed the furnace himself. It was particularly valuable in his case, because he had three or four outlets for dust and what was worse than dust—the refuse from shale. He found that the furnace used these up most admirably.

Mr. Sellers laughingly repudiated having introduced the subject for the purpose of advertising the furnace, or for the sake of getting a commission. (Laughter.) He did it solely for the benefit of his colleagues.

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The PRESIDENT said he did not for one moment suppose that the view which had just been mentioned was taken of the question. He rather took it that it was a response to what he said in his address, when he asked members, if they did not read a paper, to bring before the Association such matters as had been referred to, so that gas managers, who were so much isolated from each other as not to be able to see every day the improvements that were taking place, might have an opportunity of knowing from those who had used new processes how they worked. A step in the right direction had been taken. He had not himself tried this furnace, though the patentee had been down to see him with reference to it. In his own case, all the breeze they made they used themselves, in preference to coke or coal, for their steam-boilers. In addition to this, they had a great demand for it in the town, though at present they were not able to sell any. They found it answer their purpose very well. At present they were using coke for their boilers because they had not sufficient breeze. For their exhauster boiler, they found breeze to answer equally well, with a saving of 4s. or 5s. per ton. In places, however, where there was no demand for breeze, this furnace was a step in the right direction; and it would also tend to reduce the price of gas. He believed in introducing anything which would yield 10 per cent. on the outlay. If anyone could prove to him that an invention would realize 10 per cent. return upon the original cost, he was always ready to introduce it, or to consider its introduction, provided he saw no disadvantage in its use. In this case he thought the invention was one which might be used with considerable advantage.

VOTES OF THANKS.

Mr. R. BRIDGE (Doncaster) thought it was their duty to record their thanks to the President for his very able address that day, in which he had brought matter before them for their entertainment and for their future profit.

Mr. G. A. ALLAN (Willington) seconded the motion. In doing so, he advocated something being done with reference to the formation of a Committee to try and effect an undertaking about the sizes of gas-retorts. There was, he said, a great deal more in this matter than many gas managers seemed to think. If a maker had to produce some 40 or 50 different sizes and patterns of retorts in the course of a year, he could not keep a stock. Supposing a manager had one or two retorts broken when on the road to the works, and the maker had not any left, a bed was at once laid idle. Instead of merely making a suggestion, he thought that

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something ought to be done. The President should name a Committee, so that they might consider the subject, and report at next meeting. There was, again, the subject of the consumption of gas in gas-engines. Gas managers often recommended gas stoves and engines to the public; but they did not use gas-engines themselves. If they required more power, they put in a boiler and steam-engine. Why did they not employ a gas-engine instead? They would find it a great deal cleaner and cheaper; and they could then urge it with more freedom upon people outside. He had great pleasure in seconding the motion, because a better or a plainer address to gas managers he had seldom heard.

The resolution having been agreed to,

The PRESIDENT expressed his great obligation to the meeting for the vote of thanks which they had accorded to him. What Mr. Allan had said about the employment of gas-engines embodied a view of the circumstances which ought to be taken more into consideration. As they would see, when they went round his works, he had a small gas-engine which blew the bellows in the blacksmiths' shop, and another gas-engine which worked a lathe and other machines in the fitters' shop. They had not gas power in other parts of the works, for the simple reason that they were not prepared to throw out plant which was otherwise good, in order to introduce gas; but when opportunity occurred, they should be glad to make use of gas.

Mr. HEPWORTH, on behalf of the Association, proposed a resolution acknowledging the kind reception which had been accorded to the members by the Hartlepool Gas and Water Company.

Mr. J. NICHOLS (Darlington) seconded the motion, which was unanimously adopted.

Mr. FISHER having thanked the meeting for their vote, the business portion of the meeting concluded.

The company afterwards went round the gas-works, escorted by Mr. Bower. In the course of the inspection, one heard constant expressions of satisfaction at the substantial and well-appointed appearance of the works, and the perfect condition in which everything is kept by Mr. Bower. Most interest appeared to be taken in a small plant for working the Claus process, which had, however, been in operation for too short a period to allow of results being stated. A very complete sulphate plant also claimed attention, as did also a retort-setting which Mr. Bower is at present putting in, in which the air passages are arranged with a view to giving some of the advantages of regeneration without going below the usual foundations; it being impossible, on account of water,

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to go down beyond 2 or 3 feet. The party afterwards visited the pumping station in connection with the water supply of the town. An engine pumping 150,000 gallons of water per hour, partly to cisterns adjoining the station, and partly to a reservoir four miles away, was seen at work. On leaving the water station, the company drove through the extensive timber yards which are quite a feature of Hartlepool, to the docks at East Hartlepool, where they embarked, and were taken to see the new breakwater and sea-wall improvements of recent years. Landing at West Hartlepool Docks, the members and their friends repaired to the Royal Hotel, where, at four o'clock, they were entertained at dinner by Mr. Bower; the Chairman and other Directors of the West Hartlepool Gas and Water Company being present.

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MIDLAND ASSOCIATION.

QUARTERLY MEETING, OCT. 18.

This Meeting was held at the Grand Hotel, Birmingham—the PRESIDENT (Mr. Henry Hack, M. Inst. C.E., Engineer of the Saltley works of the Birmingham Corporation) in the chair.

The HON. SECRETARY (Mr. W. R. Cooper, of Banbury) read the minutes of the previous meeting, and they were confirmed.

ELECTION OF NEW MEMBERS.

The PRESIDENT proposed the election of the following gentlemen as members of the Association:—Mr. E. H. Millard, of Hinckley; Mr. J. C. Belton, of Wellington, Salop; and Mr. W. W. Hulse, of Longton.

Mr. TAPLAY seconded the motion, which was carried.

THE PROPOSED LECTURES ON GAS MANUFACTURE.

The PRESIDENT: Gentlemen,—You will remember that at the last meeting in Birmingham, a Committee was appointed with reference to the matter of lectures on gas manufacture. They have since had the subject under consideration, and have seen Dr. Tilden, of Mason's College, and discussed the idea fully with him. He kindly stated that he believed the Governors of Mason's College would be willing to further the object as much as was in their power; and, subject to the approval of the members of the Association, he himself would in January next undertake to give a course of lectures upon the chemistry relating to gas manufacture. The Committee recommended that this offer be accepted. They believe the funds at their disposal will cover the cost of the lectures. I therefore beg to move—"That the recommendation of the Committee be approved, and that they be authorized to arrange terms and all other matters with Dr. Tilden."

Mr. W. NORTH (Stourbridge): In order that the matter may be discussed, I will second the motion.

Mr. H. TAPLAY (Stoke-on-Trent): In rising to move an amendment, I would remind the meeting that, when this subject was first discussed, it was decided that a professional man should be employed to give instruction to the members of the Association. This was slightly modified some time afterwards, on the proposition

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of a member of the Council of The Gas Institute, that the funds to be employed for the purpose be thrown into the general funds of The Gas Institute. [A VOICE: No; not "thrown into the funds."] Well, the money was virtually to be voted for The Gas Institute.

The PRESIDENT: Voted for gas lectures.

Mr. C. HUNT (Birmingham): In conjunction with The Gas Institute, to be expended in this locality.

Mr. TAPLAY: As The Gas Institute will probably undergo serious revision, I desire to propose that the matter be left open for the present, and that the money for the lectures be not voted at this meeting. When the Institute is revised, and matters put straight, we may consider the whole matter again.

The PRESIDENT: I am bound to point out that the money has already been voted. You can propose that the matter be deferred, but not that it shall be rescinded, without giving notice.

Mr. TAPLAY: I do not want to rescind it at the present time; but I simply wish the consideration of the expenditure of the money to be deferred.

Mr. V. HUGHES (Tipton): Is the money being expended in connection with The Gas Institute?

The PRESIDENT: It is not intended to be expended in connection with The Gas Institute.

Mr. HUGHES: Then it is not being spent in accordance with the resolution.

The PRESIDENT: It is not being expended at all at present.

Mr. HUGHES: To my mind, the resolution does not want rescinding, because it is a new scheme that is suggested by the Committee; and we may either accept or reject it.

The PRESIDENT: It is only carrying out the idea approved at a previous meeting. The lectures were to be entrusted to a Local Committee; and this Committee has been formed by you.

Mr. HUGHES: And the funds of The Gas Institute were to assist us; but we are getting none.

The PRESIDENT: Not at present.

Mr. HUGHES: What I want is information on the subject. First it was proposed to have special lectures for ourselves; and then we had a scheme which was to be in connection with The Gas Institute. But now we have another proposal without The Gas Institute.

Mr. HUNT: I am sure that what the President intended to explain was that the first thing this meeting has to determine is whether or not we shall go on with the scheme in the present unsettled state of affairs with respect to The Gas Institute. Your

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Committee deliberated on this point; and having regard to the fact that they were able to place before you a scheme on all fours with that which would in all probability have been adopted in conjunction with the Institute, and at a cost not exceeding the sum voted by the Association, they felt it to be their duty to put the matter in your hands. We have, however, no feeling at all on the subject. If you adopt the resolution, you will be doing precisely the work which was intended in conjunction with The Gas Institute; but it is for you to say whether we shall go forward alone, or postpone action for, perhaps, an indefinite time.

Mr. B. W. Smith (Smethwick): The reason of this matter being introduced to-day was that, in view of the unsettled condition of The Gas Institute at present, the Lecture Committee did not think it wise to defer it for another year. Hence they thought it better to bring forward some proposition for the meeting to discuss.

Mr. W. Winstanley (Newcastle-under-Lyme): Is it proposed that the lectures shall be in Birmingham only, seeing that some of the members come from Derby, North Staffordshire, Shrewsbury, and other places at a distance?

The President: The present recommendation is that the first course shall take place at Mason's College.

Mr. Winstanley: Then I will second the amendment, as I think the lectures should be arranged to be given in different centres, so as to meet the requirements of members living at long distances from Birmingham, and who could not possibly attend if they are to be restricted to Birmingham only.

Mr. P. Simpson (Rugby): When the question of our balance was referred to, it was thought it would be a good thing to have an experienced man to give lectures to the Association; but when The Gas Institute took the question of technical education in hand, and proposed that courses of lectures should be given in different parts of the country, we thought it better to wait and see what they would do. As, however, things have taken the course they have, I do not think we should ignore the wishes of our members by passing the matter over. We considered it our duty to recommend that a lecture or lectures be given; and it was considered that we were only carrying out what was your wish, before the Institute recommended their proposal. We have no desire to work against the Institute. Considering the offer we had from so experienced an authority as Dr. Tilden, the Committee thought if they could arrange for a course of lectures in Birmingham, which is our centre, they would be meeting the wishes of the members.

Mr. Taplay: That may have been understood by the Committee, but not by the members. In my opinion, and that of members I

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have spoken to, with the assistance of The Gas Institute, we should have a lecturer for the members of the Midland Association. Well, now, the proposed lectures are not confined to the members of the Midland Association, but are to be open to students; and everyone connected with gas-works could come in by paying a small fee. I did not look at the matter in that light, and did not understand it in that way at first. I thought it was proposed to have a series of lectures throughout the country, in centres where men in years could go and learn something. I take it that, as members of this Association, we do not want elementary lectures. If you have a lecturer who gives advanced views to a lad of sixteen, what good would that be to me? We want a man from whom we can learn something ourselves. Speaking personally, I am a little disappointed. I have no doubt the Lecture Committee have very fully weighed the matter; but I do not see what advantage the whole of the Association would get out of it. You take the Association's funds, and pay them to a lecturer for somebody else; and it may be made a whip for our own backs. I confine myself now to moving an amendment to defer the matter; and, if necessary, I will give notice that the resolution be rescinded at the next meeting.

Mr. HUNT: Allow me to correct Mr. Taplay. It was not intended by the resolution adopted at the meeting of The Gas Institute last time to provide lectures for members only. Members were to have the privilege of attending the lectures free; but it was not contemplated to exclude others, who were to be admitted on payment of a fee. In the proposal before the meeting, we should not be departing in the slightest from the original proposition submitted to The Gas Institute and discussed at the June meeting. It is on precisely the same lines as then laid down, and upon which the Institute Committee would now have been at work had they continued in existence.

Mr. TAPLAY: I accept Mr. Hunt's explanation; but the matter was not in the minds of the members generally in that shape.

The PRESIDENT: I admit that at the last meeting in Birmingham, there was at first some little doubt as to what was intended; but, after the explanations given, I take it the members knew perfectly well what was proposed. Mr. Taplay has been speaking of the benefits of a lecturer for ourselves, as compared with The Gas Institute scheme. They are, of course, two quite distinct things. I may say that it is proposed to have six lectures for a course; and no doubt one of them can be made to coincide with the date of the February meeting of the Association.

The amendment was then put to the meeting, and carried by ten votes to seven.

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Discussion on Mr. Lewis's Paper.*

The members then proceeded to discuss the paper presented at the previous meeting by Mr. J. T. Lewis (Wellingborough), entitled "The Competition of Petroleum with Gas for Lighting Purposes."

The President: I regret that at the Bath meeting we were obliged to take Mr. Lewis's paper as read, and to defer discussion upon it. The delay, however, has given you the opportunity, so often desired, of seeing the paper in print before it was read; so that you should now be better able to discuss it. The paper went a little beyond its title, and for the purpose of discussion may be divided into two parts—First, the subject conveyed by the title; and, secondly, the policy of gas companies or gas undertakings towards their consumers.

Mr. J. S. Cranmer (Stratford-upon-Avon): Our thanks are due to Mr. Lewis for bringing the subject before the meeting at Bath; and I am sorry we could not discuss the paper then, although possibly during the interval we may have had time to digest it, and to bring our experience to bear upon it. Last week, through the kindness of the Editor of the *Journal of Gas Lighting*, a letter was inserted asking for information on this subject.† The Gas Committee of my Corporation are very anxious to assist me in endeavouring to drive out what I may term our strongest competitor—petroleum oil; and they requested me to obtain all the information I could on the subject. I forwarded the letter I have mentioned to the *Journal;* but I am sorry to find there are no replies this week. The reason why, I am unable to say. Whether it is from the lack of information, or from that natural—I would not say timidity—but modesty on the part of managers in general in regard to furnishing information, I cannot say. Mr. Lewis has very kindly given me information; and I trust I may yet gain some from other sources. It appears to me that the question of supplying gas to small consumers is one that should be taken into consideration, not only by gas managers, but by corporations and gas companies. There is a wide field open in this direction; and it is only by determining the best means of dealing with the matter, that we shall be able to drive out our competitor. In my case, we have been repeatedly asked by people who would be small consumers, if we would supply them with gas. Under our present rules, we are unable to do so. If we afforded them a supply, the difficulty at the end of three months would be to get payment. Now, I do not see any reason why we should not adopt the same plan as is carried out by those who go out

* See *ante*, p. 137. † See number for Oct. 9, 1888 (p. 636).

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selling oil in small quantities, and who collect the money weekly. One difficulty, I see, is the provision of gas-fittings for these small customers. In the majority of cases they are not in a position to pay even 20s. for fitting up a house. The owner of the property will not do it; and the result is we are losing consumers, who, I am confident, would pay us equally well as some other classes. A little more trouble might be caused to the manager; but I contend these customers would pay us equally as well as some of the larger consumers. If any plan could be adopted for providing gas-fittings and charging a small rent for them, we might be able to provide alike for the cottager and artizan at quite as cheap a rate as the oil-man does at the present time; and we should all reap a benefit by so doing. At present I have not done anything beyond making inquiries; but if these inquiries lead to satisfactory results, I shall be pleased to make them known to the Association at some future time.

Mr. P. SIMPSON (Rugby): I cannot give any information on the question of Petroleum *v.* Gas; but I have heard it stated by other managers that the bad debts amounted to such a considerable sum for the gas consumed by small customers, that it was one great drawback to supplying them. I think, with Mr. Cranmer, that it would be a great benefit to all gas companies if they could get into the way of collecting the accounts from small consumers more frequently. I have in several instances had to cut off the supply to small consumers, because in the winter quarter it comes to rather a considerable amount, and there is not that forethought which perhaps was more prevalent in old times, of laying up for a rainy day. As a rule, the working population live from week to week; and to take the amount of a quarter's gas account out of a week's wages might sometimes cause a difficulty in the family. If we could collect the money more frequently, it would be a help in supplying small consumers. In my own case I supply 889 cottages, and 630 shops and large houses—a total of 1519. I have taken a district of two streets, which contain about 400 cottages, of which about 156 use gas; the average consumption in 1887 being 9314 cubic feet for each cottage. The cottages in these two streets are not built as many are. They are all freeholds; but there are very different classes of cottages in the same street. We have numbers of cookers in use in these streets; and there are differences of degree in the consumption, which may make the average gas consumption appear large. Taking the last five years, the average annual consumption of the 889 cottages was 8,389,000 cubic feet; and of the 630 shops and large houses, 26,463,000 cubic feet. This gives an annual

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consumption of 42,000 feet for the larger consumers. Taking the five years, I have had for these 889 cottages, on an average, bad debts amounting to £3 13s. 9d. per annum, and for the 630 shops and large houses an average of £12 0s. 6d. This gives for the cottages bad debts averaging 0·09d. per 1000 cubic feet; and for the larger consumers, 0·11d. Now, as a compensation against this loss by bad debts, the price is 3s. 2d. per 1000 cubic feet, with 2d. discount if paid in a given time. During the past five years, the average amount received per annum from those who have lost their discount is £29 12s.; so that, after deducting from this the bad debts (£15 14s. 3d.), there was still a balance left of £13 17s. 9d. above what would be received if all had paid 3s. per 1000 feet. I may say a great drawback to cottagers having a supply of gas is the requirement in some instances of a deposit and a charge for laying the service-pipe. At Rugby, we do not ask for a deposit; and we lay the service within the house. In my opinion, small consumers would not, as a rule, pay deposits. I have never tried to obtain them; and do not think I should be likely to succeed if I did. We collect our accounts every quarter. The accounts are made up (say) to Sept. 30. The bills are then delivered; and every customer is seen twice before the end of October. This gives them the benefit of the discount if they pay; and the second time the collector goes round, he takes a considerable amount of money. After the second month, unless the customers pay, the supply is discontinued; and they are put into Court. I have contemplated bringing before my Board the question of more frequent collections.

Mr. E. H. Millard (Hinckley): I am strongly of opinion it does not pay to foster a consumption among small consumers, especially where, as in Mr. Simpson's case, you put in the services free, and allow the consumers to have meters without charging hire. Even if you take the interest on the outlay at the small figure of 5 per cent., there is also the cost of collection, and other matters. Mr. Simpson says that he has an average consumption in the case of his cottage consumers of more than 9000 cubic feet. In my own case at Middlesbrough, before I went to Hinckley, the consumption was about 8900 cubic feet. It really does not pay; but with the object of broadening the basis of the gas-works, we did try to foster consumption in this direction, hoping that we should also obtain increased consumption by the use of gas-cookers. We arranged in all cases where landlords would put in the internal pipes, to fix the service-pipe and meter without any charge. A good many of them did so; and it was always found that these cottages let the best. Of course, there is a residuum of population

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of a migratory character, whom it would not be worth while having as gas consumers.

The PRESIDENT: Do you include the consumption by cookers in the figures you have given?

Mr. MILLARD: Yes. There were usually two lights in the cottages I referred to. In the end, the landlords began to make recesses for the cookers; and it saved the expense of a range in the back places.

Mr. HUNT: I was glad to hear Mr. Millard's remarks, because it has appeared to me that, in discussions upon this subject, it has too frequently been assumed to be the special mission of gas suppliers to oust all competitors, without any regard to cost. Gas supply ought surely to be on the same footing as any other business, in respect to which blame would attach to anyone carrying it on at a loss; and the first thing to determine is whether or not the new business we are seeking to acquire is likely to prove remunerative. If it is not, it cannot matter whether oil or candles be used, or even the electric light. I remember that, in the time of the Companies, it was said in Birmingham of a certain class of consumers that it would pay to put in the service-pipe, supply and fix the meter, and then never go near the premises again—that is to say, the consumption was insufficient to cover the cost of attendance upon the meter and collection, to say nothing of depreciation and interest on the cost of service-pipe and meter. Without going so far as this, it is evident from the smallness of consumption in cottage property generally, that caution is necessary in extending the business in this direction. It may be quite true that it cannot be said of any single consumer, "This one pays; and that one does not," in the sense of supporting a gas undertaking; but having regard to the class, rather than the individual, we can at once recognize the difficulty that would be experienced with a gas undertaking whose consumers were solely composed of small cottage occupiers, having say two lights apiece. It must be apparent that an average consumption of 4000 to 5000 cubic feet per annum could not be supplied at so cheap a rate as an average consumption of say 20,000 or 30,000 feet; other conditions being the same. Moreover, in the migratory character of a large portion of the smaller occupiers, especially in the larger towns, there is an element of insecurity, which can only be met by a system of very short collection, or prepayment by meter or otherwise. In this respect Mr. Simpson's plan appears to have been very successful, although he is evidently more favourably situated than are many others. In regard to the extension of gas consumption generally, I feel

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convinced that Mr. Simpson is on the right track. Some years ago I had occasion to make enquiries upon the subject, and procured returns from various towns—Mr. Simpson's among the number. I was greatly impressed by the proportion of consumers to population, and consumption per head of the population; for these bore a very close relation to the policy adopted towards the consumers. Where restrictions were in full force—the deposit and guarantee system in full swing, there the consumption was least. On the other hand, where a liberal policy was indicated by the information afforded by the returns, there the use of gas was proved to have widely extended limits. In this way the consumption per head of population was shown to be actually less in the case of a large manufacturing town than in that of a comparatively small town having a semi-rural population. When looking at a balance-sheet, it is too often assumed that a small amount for bad debts is an indication of good management. I am not sure that it may not sometimes be the reverse. At all events it is most probable that the growth of business would in many cases be more satisfactory if a liberal policy were allowed to prevail.

Mr. H. TAPLAY (Stoke-upon-Trent): I can endorse Mr. Hunt's remarks. In our Potteries district, we have a population similar to his own—a migratory one. One inducement we gave to this population to use gas was to do away with meter-rents and fix meters free. This led to about 50 new consumers with a consumption of 400,000 or 500,000 cubic feet a year; but our net loss at the present time will be about £500 a year in meter-rents.

Mr. NORTH: That means you dropped your meter-rents all round?

Mr. TAPLAY: Yes.

Mr. J. A. HARRIS (Wigston): With regard to the use of petroleum for heating purposes, I may remark that at Wigston experiments are being tried at one or two shoe factories to heat irons by this means. The only drawback is that the irons are blacked. I should like to ask if there is any case where heating by petroleum is carried out successfully. With regard to the supply of gas to cottages, in my opinion we need caution. If a genuine good tenant will take gas, we ought to make it as easy as possible in the first place to start the consumption, by laying the service-pipe and fixing the meter free of cost. In the case of cottages not already fitted up, it would also be to our advantage to do the work at a small margin of profit. The start is the principal thing. If we know people are likely to be sure tenants of a cottage, and gas-fittings are not fixed in it, it might be advisable for some one from the gas-works to see the landlord. There are tenants who would be willing to pay a penny a week more if the landlords provided

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the gas-fittings. In a new district, where there is a population of about 2000, we have experienced more difficulty than in all the other parts of Wigston. I find one factory is worth a hundred of such consumers.

Mr. W. R. Cooper (Banbury): In our case we try to meet the small consumers as liberally as possible. We do nothing in the way of fitting up houses; and the consequence is that the tradesmen have gone more into the petroleum lamp than the gas-fitting business, as, after selling the lamps, they continue to supply the oil. I thought of suggesting to the Directors of my Company that they should try and revive the trade in gas-fittings by offering the tradesmen a premium upon all the gas-fittings they sell; so that there might be a fair competition with the lamps.

Mr. North: Why not go into competition with them? You can afford to sell gas-fittings cheaper than they can.

Mr. W. Winstanley (Newcastle): I should like to ask if any members present have tried the prepayment meter. I was instructed by my Committee to obtain one of these meters to experiment with. I have done so; and I find that the pence dial works backwards. It may be that this is right, to show the amount of gas paid for and the quantity to be burnt. I have tried it with a penny; but the penny will not go down. There it sticks; and still the gas goes on burning. (Laughter.) One of the members has spoken of supplying the services free. I do not find that it has increased the ratio of consumption over what it was before adopting this principle. As regards the deposit system, perhaps that may interfere with the increase of consumption. In my case, 5 per cent. is allowed upon all deposits. I find that the bad debts have decreased, while the consumption has increased, which may perhaps arise from better collection. Mr. Simpson is very favourably circumstanced in the matter of cottage consumption; but if I supplied cottages in the way he does at Rugby, I should very likely find a few hundreds increase in bad debts. The idea of adopting the prepayment meter is to increase this class of consumption, and at the same time make sure of the cash.

Mr. Simpson: Is not the dial of the prepayment meter meant to go backwards when you put a penny in? It goes round to the 12; and you cannot put any more pence in. Perhaps you have broken the action with your penny.

Mr. Harris: There is a dial registering up to twelve for each penny put in. It goes forward—one, two, or three, and so on up to twelve; and then it travels back. I have the greatest confidence in the meter.

The President: As to the idea of increasing the consumption

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in cottages, although I agree with previous speakers that we should not take business at a loss, I think our aim should be to bring into our fold all consumers who will in the long run benefit us; and that we should not stick at trifles, but remove, as far as practicable, all the old discouraging restrictions to the use of gas from all consumers—small consumers though some of them may be. On the Continent, they look at the whole question very broadly. They bring the service from the street, and take it right up through the various floors of the house free of cost. No doubt charges for fixing meters, deposits, and for one thing and another are vexatious, and form a stop-block in the way of a small consumer entertaining the idea of using gas. I notice that, during the discussion, nothing has been said with respect to Mr. Lewis's figures, which he had so ably prepared for us in tabular form in the paper. One advantage of delaying the discussion upon it has been, as I said before, to give us time for a full consideration of them; and, availing myself of it, I thought I would ascertain for myself what was the cost of burning ordinary petroleum oil, as compared with coal gas. I am living in the country just beyond the limits of gas supply, and am compelled to use oil-lamps. I use Hincks's duplex lamps with petroleum oil; and the oil costs 9d. per gallon delivered. With the flames of my lamp set at right angles to the photometer bar, I obtained an illuminating power of 21·52 candles; and with the edge of the flames towards the bar, only 12·01 candles, or 56 per cent. less (which is about 4 per cent. less favourable for the edge of the flame than Mr. Lewis found). One quart of the petroleum oil lasted 14 hours 12 minutes; the cost at 9d. per gallon being 2¼d., or 0·16d. per hour. Taking the *mean* of the illuminating power of the flames, edge and full, it is equivalent to 5·23 cubic feet of gas of 16-candle power per hour. Adopting 3·2 candles per cubic foot, at 3s. per 1000 cubic feet, the cost of an equal light by gas for the same length of time would be 2·67d. against 2¼d. from the oil—or 3·42d. against the 2¼d. if the comparison be made with the higher lamp-power of 21·52 candles. The power recorded for the full-flame tests gives a value of 1215 candle power per gallon per hour, as compared with Mr. Lewis's 1287 to 1459; and my tests bear out his calculations that oil at 9d. per gallon is about equal to gas at 2s. per 1000 cubic feet, of an illuminating value of 3·2 candles per cubic foot. I am, however, of opinion that, notwithstanding the improvements which have taken place in gas-burners, principally in those of high power, 3·2 candles per cubic foot is too high a standard to adopt for the comparison with petroleum lamps. Such lamps as these are principally employed in places where ordinary fishtail or other

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flat-flame burners would be fitted if gas were employed; and with such I think that perhaps a mean between the late Mr. Hartley's figures, mentioned by Mr. Lewis, and 3·2 candles would be fairer, if not still too high a value for the comparison—3·2 being the result obtained at present with the standard Argand burner. Reckoning therefore, the value of the gas per cubic foot in candles, at an eighth less than Mr. Lewis has done, it alters the comparative cost of gas in his duplex burner table from 15·16d. to 17·31d. as against 9d., or nearly double the cost of oil; and at 2s. per 1000 cubic feet, 11·54d., as against 9d.—or 28 per cent. dearer. I quite agree with Mr. Lewis's statement in his paper that the truth should be known; and if we do not bring it out, or in any way attempt to "scotch it," it will nevertheless come to the front. I therefore hope he will excuse me disagreeing with his figures as to the cost of oil compared with gas. From the experiments I have made, and my general knowledge as to the cost of petroleum, I feel that, as regards expense, light against light, we shall not be able to "defy all competition," unless 17-candle gas can be sold as low as 2s. per 1000 cubic feet. Anything above that figure will, if cost alone be considered, put the general adoption of gas by very small consumers out of the question if looked at apart from the matters of safety and convenience, which are so much in favour of gas. Mr. Lewis has referred to an excellent paper by Mr. Dalgliesh.* It would be valuable information if Mr. Dalgliesh would at some future time kindly add to his interesting figures the price of gas in the different towns to which he refers in his paper, where he shows that the non-consumers vary from 8 to 81 per cent. It will give us an opportunity of judging more fully if it is the price of gas which adds materially to the disposition of the non-consumer to use petroleum rather than gas.

Mr. J. T. Lewis (Wellingborough): The discussion to-day has, I think, been on the whole favourable to the views I hold. Some members seem to consider it is not advisable to push the sale of gas in cottage property, without being quite certain that it is going to pay, or more than pay, for the extra expense incurred through dealing with this class of property. In my opinion, it is necessary that we should try and get hold of this class of consumer; and therefore we must, in the first instance, treat it as an experiment, and afterwards be guided by the results, which may entirely differ in different districts according to local circumstances. No doubt, in large towns, such as Birmingham, the migrating habits of many cottage occupiers makes it very difficult to supply

* See "Reports of Gas Associations" for 1887, p. 316.

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them with gas on the usual terms; and the endeavour to do so, on the system of quarterly payments, might add to the bad debts account. If, however, a system of weekly collections was adopted, I believe this class of people might with advantage become our customers. The frequent visit would almost, if not entirely prevent loss; and although the cost of collection is greater, I think, this is preferable to a system of monthly collection, or the use of a prepayment meter, the employment of which would necessitate at least monthly visits, when perhaps at the end of the month you might find your customer had removed, or that the meter had been tampered with. I must congratulate Mr. Simpson upon the smallness of his bad debts, and also upon the average consumption of his cottages; both being very good. Mr. Millard is under a mistake when he speaks of Mr. Simpson and myself supplying meters free. We do not do that. In my own case, we charge 1s. per quarter for 3-light meters. In reply to Mr. Harris, as to the use of petroleum to heat shoemakers' irons, gas is largely used in our district for this purpose; and although it is possible to heat these irons with petroleum oil, and some do it, I have not met with anyone who could get a supply of gas on favourable terms who did not prefer gas for the purpose—the advantages being altogether in favour of gas. During the past few months, we have laid down mains for the supply of a village of 2000 inhabitants, where scarcely anything but petroleum oil was previously used for lighting purposes. Our price for gas there is 3s. 4d. per 1000 cubic feet, with 2d. discount; and at this price, I am glad to say that many of the people have taken gas, and were only too glad to get it, in place of petroleum—clearly showing that it is not altogether a question of cost light for light. In this place I have been fortunate enough to induce some owners of cottages to put in gas pipes and fittings; so that the occupiers can take the gas on the weekly system without any expense, beyond that of the gas consumed and the meter-rent. I should recommend Mr. Cooper to take the supply of fittings into his own hands, instead of offering a premium to the oil-lamp sellers on the gas-fittings they might sell. He could supply the fittings at less cost, and would understand the requirements of his customers much better than the shopkeepers, besides having the control of them in his own hands. With regard to the question which the President has raised, as to the amount of light given by an ordinary burner per cubic foot of gas, I adopted the value of 3·2 candles because I did not wish to be below the mark in my comparisons; but I quite agree with him that, in the bulk of cottages where oil is used, such a high value as that would not be obtained. I think his figures of

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2·8 candles per cubic foot are quite high enough; and I should be perfectly willing to adopt his figure, if I was going over the matter again. In a paper read by Mr. L. T. Wright, late of Nottingham, before the Society of Chemical Industry,* he compared the value of petroleum and paraffin oils with gas as supplied at Nottingham. He allows a value of 3·5 candles per cubic foot for ordinary flat-flame burners. This I consider much too high, even when used with 18½-candle gas. With this exception, I find that his results agree closely with my own experiments; and I am pleased to know that our President's tests also agree with mine. It is of the greatest importance that we should make only true statements to our customers as to the value of the light obtained from the gas used with various burners. A short time ago a pamphlet was given me on the subject of the supply of gas to consumers; and in it I found very misleading statements, such as no one connected with gas undertakings should send out, and which would certainly lead to trouble with our consumers. Our President says that gas must not be above 2s. per 1000 cubic feet to be able to compete with petroleum. This is true when comparing the light given by each illuminant; but something must be allowed for the advantages which gas undoubtedly possesses over petroleum. As an instance of this, I may mention that a few weeks ago I attended a meeting of manufacturers and others held in a village of 3000 inhabitants, to take into consideration the advisability of obtaining a supply of gas; and without any figures being given them, their own conclusion was that, if gas could be supplied at 4s. per 1000 cubic feet, they would burn it in their homes and factories instead of petroleum. Notwithstanding that petroleum is such a severe competitor, I think if we take such steps as weekly collections, and offer every facility for getting gas, we shall do a great deal to meet, if not to stop altogether, the competition which we are experiencing at the present time. Though I cannot speak definitely on the subject, it may interest some to know how we have succeeded with the weekly system since we started it in July last. During the quarter we had 16 consumers on this system—the lowest average weekly payment, 3·3d., and the highest where a cooking-stove is used, 1s. 7·61d., or an average for each of 5·94d. per week. We have now 30 customers on this system, and have orders for many more to be put on. In conclusion, I beg to thank you for having listened to me so patiently.

Mr. Cooper: With regard to the question of offering premiums to tradesmen, my idea is that in doing so we should not create a

* See *Journal of Gas Lighting*, Vol. LI., p. 1002.

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rivalry; we should not have any bad debts, and there would be no capital required for carrying out my suggestion.

The PRESIDENT: I rise to move a very hearty vote of thanks to Mr. Lewis for his paper, which has been so well discussed to-day. I hope some other members present will take a leaf out of his book, and bring before us next year papers on subjects of mutual interest.

Mr. B. W. SMITH (Smethwick) seconded the motion, which was carried with applause.

Mr. LEWIS: I thank you very much. I only felt I was doing my duty in preparing the paper. I shall be pleased at any future time to do anything I can for the Association.

Mr. C. TAYLOR (Derby) then read a paper entitled—

AN OFT-REPEATED QUESTION:
ARE HIGH CARBONIZING TEMPERATURES CONVENIENT AND PROFITABLE?

Mr. President,—My time and attention have been so largely occupied lately with other necessary work, that I could gladly have avoided adopting your suggestion to provide a paper for the attention of members at this meeting. I, however, felt it my duty to obey your call if possible; and in casting about for a subject, I adopted, as most ready to hand, a question which, in one form or another, has been very frequently repeated—viz., that at the head of my paper. There are, I believe, many gas managers who still incline to the opinion that the disadvantages arising from the employment of high heats outweigh the advantages; and this fact provides me with an excuse for again presenting the question.

The disadvantages to which the advocates of low heats refer are enumerated somewhat as follows:—

1. Stoppages in ascension-pipes and hydraulic mains, &c., due to deposits of pitch.
2. Stoppages in manufacturing plant and in distributing mains and services, due to deposits of naphthalene.
3. Reduced quantity and quality of tar.
4. Reduced quantity of ammonia.
5. Reduced illuminating power.
6. Increased quantity of sulphur compounds.
7. Increased consumption of fuel.
8. Increased wear and tear of retort-settings, &c.

We probably agree that, subject to qualifications, these charges, or some of them, are correctly made out; and I propose to estimate, as closely as I can, the degree in which they prejudicially

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affect the cost of production, when the make of gas is raised, for example, from 9000 to 10,000 cubic feet per 20 cwt. of coal carbonized.

I may premise that the tendency to stoppages by pitch and naphthalene has been met, minimized, and modified in various ways—as by the rotative use of different qualities of coal, by reducing the seal of dip-pipes, by the separation of tar from the gas immediately upon their arrival at the hydraulic main, by water-jacketing, steaming, and the occasional lowering of temperature, &c. But these expedients are not always successful; and when they are found to be so, some cost and labour are involved in their application.

I estimate the disadvantages as follows:—

1. The element of stopped pipes, due to pitch, varies with the special circumstances of each works; but, so far as my experience and inquiries have extended, I am unable to put down the loss under this head at more than ½d. per 20 cwt. of coal, when carbonized at a temperature to yield 10,000 cubic feet.

2. A similar sum—viz., ½d. per 20 cwt. of coal—cannot, I think, be exceeded for cleaning out stoppages due to naphthalene, both inside and outside the manufactory.

3. I have found experimentally that an increase of 1000 cubic feet between about 9000 and 10,000 feet has decreased the production of tar by one-third to two-thirds of a gallon, while its specific gravity has increased ·02 to ·025. The money loss due to diminished quantity and increased specific gravity will vary as the demand for certain products or distillates preponderates; but, assuming the value of the tar at 1d. or 1½d., we may adopt 1d. as the loss per 20 cwt. of coal carbonized.

4. It is, I think, well recognized that low temperatures give low yields of ammonia; and Mr. Lewis T. Wright has shown that the maximum of this product is realized when coals are distilled to produce about 10,000 cubic feet of gas per ton. I calculate the additional ammonia due to an increase of 1000 feet of gas at about 7 per cent.; and its value at 0·75d. to 1·5d. per ton of coal.

5. On reducing a series of records by the same authority, I find that an increase of 1000 cubic feet of gas upon a production of 9484 cubic feet obtained from Derbyshire coals, gives a reduction in illuminating power of not exceeding one-fifth of a candle; and I value this at 2d. per ton of coal.

6. The increase of sulphur in the unpurified gas is found to be about 7·5 grains per 100 cubic feet when the production is increased by 1000 cubic feet. This works out to 28 per cent., which at a mean cost for purifying of 5·15d. per ton of coals (as stated in

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Field's "Analysis") gives 1·44d. per ton as the cost of purifying from the extra sulphur.

7. To my mind, it does not follow that the increased temperature necessary to give an extra yield of 1000 cubic feet must require a *pro ratâ* increase in the quantity of fuel; but as I do not wish to leave any consideration undervalued, the *pro ratâ* increase in the value may be taken at from 1d. to 2d. per ton.

8. If the extra heat implies also a *pro ratâ* increase in the cost of settings, &c., which I am not prepared to admit, we may put this also at 2d. per ton.

I estimate the cost of manufacturing and delivering 1000 cubic feet of gas into the holder, exclusive of interest on buildings, to be—

1. When producing 9000 cubic feet of 18·3-candle gas=32,940 candle-units per 20 cwt. of coal—

	s. d.	s. d.
To 20 cwt. of coal delivered into works. .	9 0·0	
,, Wages and salaries, carbonizing. . .	3 6·0	
,, Coke for fuel	1 7·0	
,, Purifying	0 6·0	
,, Wear and tear	2 2·0	
		16 9
By residuals—		
Coke	2 2·6	
Tar	1 2·4	
Ammonia	0 10·7	
Sundries.	0 2·3	
		4 6
Net cost.		12 3

And 12s. 3d. ÷ 9000 = 1s. 4·33d. per 1000 cubic feet.

2. When producing 10,000 cubic feet of 18·1-candle gas=36,200 candle-units per 20 cwt. of coal—

	s. d.	s. d.
To 20 cwt. of coal delivered into works . .	9 0·0	
,, Wages and salaries, carbonizing . . .	3 6·0	
,, Fuel (see item No. 7)	1 9·0	
,, Purifying (see item No. 6)	0 7·5	
,, Wear and tear (see item No. 8)	2 4·0	
,, Clearing pitch and naphthalene (see items Nos. 1 and 2)	0 1·5	
		17 4
By residuals—		
Coke	2 2·6	
Tar	1 1·4	
Ammonia	0 11·7	
Sundries	0 2·3	
		4 6
Net cost		12 10

And 12s. 10d. ÷ 10,000 = 1s. 3·4d. per 1000 cubic feet.

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Hence, 32,940 : 36,200 : : 12·25s. : 13·46s.; and 13s. 5½d—12s. 10d. = 7½d. profit per 20 cwt. of coal carbonized. This 7½d. upon a consumption of (say) 50,000 tons of coal per annum produces a sum of £1562.

The PRESIDENT: I am sure we are all indebted to Mr. Taylor for bringing this subject before us to-day. In my opinion it is one of the greatest interest that can be brought forward, to all engaged in gas manufacture; and I should think it will lead to an animated discussion. There may be a difference of opinion as to what really constitutes high heats and low heats. Mr. Taylor seems to define them as the difference between producing 9000 and 10,000 cubic feet, presumably from the same coal. Upon this point the members may perhaps contribute their opinion during the discussion which I now invite.

Mr. W. NORTH (Stourbridge): The paper opens up such a wide subject, that I think it would be better if we could defer the discussion. The whole question of regenerative furnaces will come in; and with such a large subject, I should be sorry to see it disposed of in the short time still at our command.

Other members having expressed the same view, as there was some further business on the *agenda*, it was agreed to postpone the discussion.

THE REPORTS OF DISTRICT GAS ASSOCIATIONS.

Mr. C. MEIKLEJOHN (Oldbury) moved—"That the reports of District Associations be no longer supplied gratuitously from the funds of this Association." His notice of motion, he said, arose from the decision to devote £10 towards establishing a centre for gas lectures, and because this would entail a deficit of about the sum granted for these reports. He gave notice of the motion as it was very unwise to propose expenditure exceeding their income; and, secondly, because he considered the £10 could be expended in a much better way. He questioned if more than one-tenth of the members read the papers, except as they appeared from time to time in the *Journal of Gas Lighting*.

The PRESIDENT said it was not intended to present the District Association reports to the members again, unless the Committee brought forward a recommendation to that effect.

Mr. HUNT stated that, owing to the unsettled state of The Gas Institute, the establishing of lecture centres had been postponed; so that the expenditure would not be incurred.

Mr. MEIKLEJOHN under the circumstances withdrew his motion

ELECTION OF OFFICE BEARERS.

The PRESIDENT: The next business is the election of President

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for the ensuing year. I beg, on behalf of the Committee, to propose the election of Mr. Charles Taylor, of Derby, to this position for the ensuing year. We have known him a considerable time; and he has been a useful member on the Committee. He has been a valuable and tolerably regular attendant at our meetings, and has taken a fair part in our discussions. He is in every respect, I think, fully qualified for the honour the Committee recommend you to confer upon him.

Mr. CRANMER: I have pleasure in seconding the proposition.

The resolution was carried with applause.

Mr. TAYLOR: Mr. President and gentlemen,—In electing me to fill the office of President, I am sure I feel you have done me a very high honour. I am only afraid that, in following so able a President as Mr. Hack, I may fail to fulfil your expectations, and to administer the affairs of the Association as successfully as he has done. I thank you very sincerely and heartily for the honour you have done me.

Mr. SMITH proposed the re-election of Mr. P. Simpson, of Rugby, as Treasurer of the Association.

Mr. F. J. NORTH seconded the motion, which was unanimously agreed to.

Mr. SIMPSON said he was much obliged to the members for their continued confidence. They were getting very rich, and ought to have some one they could trust. (Laughter.) However, he would do his best for the Association, as they seemed to wish him to continue in office.

The PRESIDENT said he was sorry to announce that Mr. Cooper felt himself no longer able to carry on the duties of Secretary. He was exceedingly unwell in February last, and felt he could not go on to the end of the year; but with the offer of help made to him, he had consented to do so till the present annual election of officers took place.

Mr. W. NORTH proposed that Mr. J. S. Reeves, of Bilston, be elected to the office of Honorary Secretary.

Mr. J. WARD (Brierley Hill) seconded the motion, and it was carried unanimously.

The PRESIDENT observed that there were three members to elect to serve on the Committee, including one to take the place of the new Secretary. He moved the election of Mr. Cooper (Banbury), Mr. Littlewood (West Bromwich), and Mr. Bell (Stafford).

Mr. WINSTANLEY seconded the motion which was agreed to.

On the motion of the PRESIDENT, seconded by Mr. HARRIS, Mr. W. T. Tew, of Warwick, and Mr. J. T. Lewis, of Wellingborough, were elected Auditors.

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VOTES OF CONDOLENCE.

Mr. W. NORTH: We have to mourn the loss of two members of the Association during the year—Mr. Collett, of Dudley, and Mr. J. H. Smith, of Sutton-in-Ashfield. It has been suggested that letters of condolence be sent to the friends of these deceased members; and I move that this be done.

Mr. SIMPSON seconded the proposition, which was unanimously carried.

VOTE OF THANKS TO THE PRESIDENT.

Mr. TAYLOR: I beg to move a vote of thanks to the retiring President for the services he has rendered to the Association during the past year, which is the second year of his presidency. I have a very high opinion of Mr. Hack, who has been as successful as he has been earnest in his efforts on behalf of the Association. I hope we shall, at no distant day, again see him in the position he has filled so well. I have great pleasure in proposing a very cordial vote of thanks to Mr. Hack.

Mr. H. WOODALL (London): I beg to second the resolution. It would be impossible to find a better man for the position he has held than Mr. Hack. He has all the qualifications which go to make a chairman. His urbanity is known to all; and he is particularly fitted for office by his care in all matters coming before him. If I want exact information, I do not know where I could go for it better than to him.

The resolution was carried, with acclamation.

The PRESIDENT: Gentlemen,—I thank you most sincerely for the kind and hearty vote of thanks you have accorded me on the termination of my office to-day. When I entered on the post two years ago, I had great misgivings as to my fitness to occupy it; remembering the ability of those who had filled it before, and that some of them had also so ably occupied the similar, yet more important, position in The Gas Institute. In deference, however, to your kind wishes, I accepted the honour; and though I may not have come up to your expectations, I can conscientiously say that I have endeavoured to discharge the duties in a satisfactory manner. I hope that the kindness and support I have received from you at our meetings and at all times will be extended to my successor.

POSITION OF THE GAS INSTITUTE.

Mr. SIMPSON: I ask the President just to allow me a minute or two. I am glad to see representatives from the Council of The Gas Institute here; and as we are at present members of the Institute, I would ask if they would put something before us, before we pay another guinea, as to what steps are to be taken to

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rectify the existing state of things. Something should be done, or some may cease to be members before any vote is taken.

Mr. WOODALL: I am sure you will all sympathize with me in the position in which I am placed. It is simply a policy of reticence which is being pursued by myself and other members of the Council up to the present. But it is, I think, more than ever desirable that every member of the Institute should continue to pay his subscription and continue on the list of members. I can scarcely say more than that. The Council meet in November; and I have no doubt our policy will be put before the members then. I do not think it is desirable I should be drawn out to say more than this now.

THE RETIRING SECRETARY.

Mr. W. NORTH, in moving a vote of thanks to the retiring Secretary (Mr. Cooper), said that, with all respect to the gentleman elected, he wished they could have kept Mr. Cooper in office longer. They owed him their thanks for his services during the past two years; and knowing himself what the work was, he had much pleasure in proposing a vote of thanks to Mr. Cooper for what he had done.

The PRESIDENT seconded the motion; remarking that it would be a great omission not to give Mr. Cooper a hearty vote of thanks Mr. Cooper had been a right hand to him during his own term of office; and he could fully understand the demands made upon him.

The motion was carried, with applause.

Mr. COOPER heartily thanked the members for the kind vote they had passed in his favour. He said he took the office of Secretary because there was then a little difficulty about it; but he had had a most excellent President to work under, and he had perhaps sometimes taken the liberty of dictating as a kind father would. (Laughter.) They had all worked together most harmoniously; and his two years' service had been a pleasure to him. He declined the office again, not because he was afraid of work, but because of being overworked; and he explained that public work in Banbury, as well as his professional work fully occupied him. Mr. Reeves would, he believed, find the same help and indulgence which he had received in holding the office.

This concluded the business of the meeting.

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SOUTHERN ASSOCIATION.

QUARTERLY MEETING, NOV. 8.

This Meeting was held in the Whitehall Rooms of the Hôtel Métropole. The PRESIDENT (Mr. J. L. Chapman, Assoc. M. Inst. C.E.) occupied the chair.

The SECRETARY (Mr. J. W. Helps, of Croydon) read the minutes of the preceding meeting, and they were confirmed.

ELECTION OF OFFICE-BEARERS.

The PRESIDENT said that his term of office was closing; and, according to the *agenda*, the proposition had now to be laid before the members to elect a new President. The Committee had—he thought wisely—decided to nominate Mr. John Somerville for the position, as he had done a great deal in promoting the welfare of the Association. He hoped the proposition, which he moved, would be received in the most cordial manner.

Mr. JABEZ CHURCH (London) seconded the motion, which was carried with acclamation.

The PRESIDENT said that, according to the rules, two members of the Committee would retire at this meeting. By some error at the last general meeting, Mr. Helps having kindly taken the position of Secretary, they omitted to elect another member in his place, so that there were three gentlemen to elect on the present occasion. Those who had consented to take office at the Committee's request were Messrs. A. Mead (Chelmsford), S. W. Durkin (Southampton), and W. E. Price (Hampton Wick).

Mr. W. H. H. BROADBERRY (Tottenham) proposed the election of the gentlemen mentioned by the President.

Mr. C. GANDON (Lower Sydenham) seconded the motion, which was agreed to.

The other officers of the Association—the Treasurer (Mr. A. H. Wood, of Hastings), the Secretary (Mr. J. W. Helps), and the Auditors (Messrs. C. Farrand and E. Price, of London)—were all re-elected.

ELECTION OF NEW MEMBER.

Mr. John Methven, of the Nine Elms Station of The Gaslight and Coke Company, was elected a member of the Association.

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The PRESIDENT said the next thing to occupy attention would be the papers. They were very much indebted to the gentlemen who had come forward to help them; and he hoped they would have an interesting meeting in every respect. Mr. Livesey had always been their friend, at their beck and call; and they had to thank him very much for bringing before the Association the subject which, of all others, was at the time so much discussed by gas engineers.

Mr. GEO. LIVESEY then read the following paper:—

THE GUIDE-FRAMING OF GASHOLDERS: HOW, AND HOW FAR, MAY IT BE DISPENSED WITH?

This question has two aspects—the first is a scientific, and the second an economical problem. Supposing the first to be settled satisfactorily in the affirmative—that guide-framing can be abolished partially or entirely—the theory is not likely to be adopted in practice unless a considerable saving can be effected.

It has been proved, both theoretically and practically, that the guide-framing of telescopic holders can be safely reduced in height without appreciably increasing the strength of the holder or the remaining guide-framing. The theory is to be found in the series of able and exhaustive articles, by "Theory and Practice," that have appeared in the *Journal of Gas Lighting* (which I hope will be published separately); and the practice is to be seen at Rotherhithe. So far as the Rotherhithe holder is concerned, the idea originated in 1881, as may be seen by referring to the *Journal* for Dec. 27, 1881, where, in a letter referring to the large holder then just completed at the Old Kent Road, I said:

"I close this letter with an idea that has occurred to me this week, and which may some day be carried out in practice. I believe it would be quite practicable and perfectly safe to erect and work such a gasholder as this with three lifts of 53 feet each, if the guide-framing reached only high enough for one lift—say 55 feet [of this I am now doubtful] in order to guide the inner holder until the second is cupped. The process would then be repeated; the second lift being guided and kept in its place until it lifted the third, which would rise to its full height and be held firmly in position by the combined radial and tangential rollers on the grip of the outside or bottom lift with similar rollers on its curb working against guides in the tank."

The principle was tested soon after, by telescoping a small holder about 8 feet diameter by 8 feet high—the inner lift having no guide-framing; and the experiment being successful, the large holder at East Greenwich, just completed, would have been built with a shortened framing, had we not been advised that the stresses on the unsupported part of the holder would be of such an entirely novel and serious nature that it would not be safe to try an

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experiment of this kind on so large and exposed a structure. The first attempt in this direction was, therefore, made in 1887 (but designed in 1886) on a more modest scale at Rotherhithe, where an ordinary double-lift gasholder, erected in 1867, 150 feet diameter by 25 feet deep, with sixteen cast-iron columns 50 feet high, and two tiers of girders, has been converted into a three-lift holder without increasing the height of the original framing, or strengthening it beyond what would have been necessary had it been carried up the extra height. The strengthening consists simply of diagonal bracing; and the only additional expense was replacing the channel-iron guides with H-iron to furnish paths for the combined radial and tangential rollers on the grips of the middle and outer lifts. These tangential rollers are the only addition to the holder necessitated by the shortened framing. The experiment, therefore, proves that a double-lift holder can thus be safely converted into three lifts with advantage on the score of economy, which is its justification; but it is very doubtful whether the ordinary framing can be further reduced without adding so much to the strength of both framing and holder as to prevent any further saving.

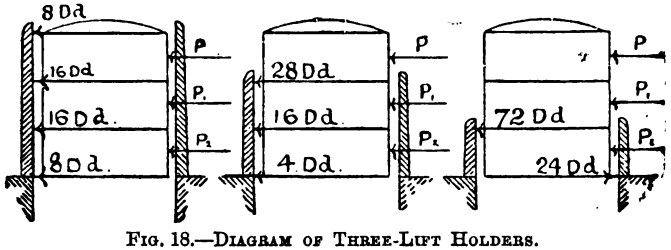

FIG. 18.—DIAGRAM OF THREE-LIFT HOLDERS.

In the first place, according to the accompanying diagram (copied from an article by "Theory and Practice" in the *Journal* of Sept. 25 last, p. 547), in a three-lift holder with framing two lifts high, the stresses on the framing are not appreciably increased; but with framing only one lift high, they become very seriously augmented—necessitating great additional strength. Secondly, there are the stresses on the bell, which are dealt with in the article on page 963 of the *Journal* of Nov. 29, 1887, where it is said that "gasholders can be constructed safely with the inner lift unsupported by external guide-framing after it has cupped, providing the guide-framing is carried to the height of the two outer lifts." But the writer, dealing with "three-lift holders one lift supported by guide-framing," says (speaking of the side sheeting acting as the web plate of a girder) the diagonal strains tending to distort and buckle the sheeting would be so great that

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he comes to the conclusion "that it is not safe nor advisable to make treble-lift gasholders with guide-framing to the outer lift only." These conclusions are repeated in his article on page 677 of the *Journal* for Oct. 16 last; and until these conclusions are proved to be erroneous, he would be a bold, if not a rash, man who ventures lightly to construct a three-lift holder with *ordinary* guide-framing to the height of one lift only.

But "Theory and Practice," at the close of the last article above mentioned, has a "Note on Mr. Gadd's Gasholder," which shows that, by a different form of guiding, the method of determining the strains must be different; and this points to the possibility of further reducing or abolishing the framing, and brings us back to the article in the *Journal* for March 29, 1887, and to Mr. Webber's paper of last year—to whom undoubtedly belongs the credit of the really original idea of constructing and working gasholders without external framing.† Until he suggested the idea, it had never, so far as I know, been even thought of; and if gasholders should ever be so constructed, the merit of the suggestion rests with Mr. Webber. After this, it occurred to me that if some means could be devised whereby the bottom curb, while free to rise and fall, could be maintained perfectly level, a great step would be made in the direction indicated by Mr. Webber. I said in the *Journal* for April 26, 1887, "if some *practicable* means could be devised whereby all the bottom rollers might be made to rise or fall equally, and none of them could either rise above or fall below the others, the holder would then to all intents and purposes have a solid foundation, and no columns or guide-framing of any kind would be necessary." Thus a holder rigidly level would be secured; and at the same time it would be free to move up or down with the inflow or exit of gas. For some time, however, the accomplishment of this object appeared impracticable; but Mr. Gadd's ingenious and novel invention of spiral guides seems to have solved the problem.

The important question now is whether, by Mr. Gadd's or any other plan, it is advisable or practicable to dispense entirely with guide-framing for telescopic holders, having regard to the want of strength in the side sheets to resist the distorting and buckling strains in an unsupported holder. By Mr. Gadd's invention we are enabled for the first time to hold the bottom of a holder in a horizontal position. It is not like a cylinder simply standing on a solid foundation; but is a cylinder (closed at the top) supported from the crown with the sides suspended therefrom, and the whole held firmly level by the rollers acting on the spiral guides. But I cannot see that this diminishes the distorting and

† See *Journal of Gas Lighting*, Vol. L., p. 171.

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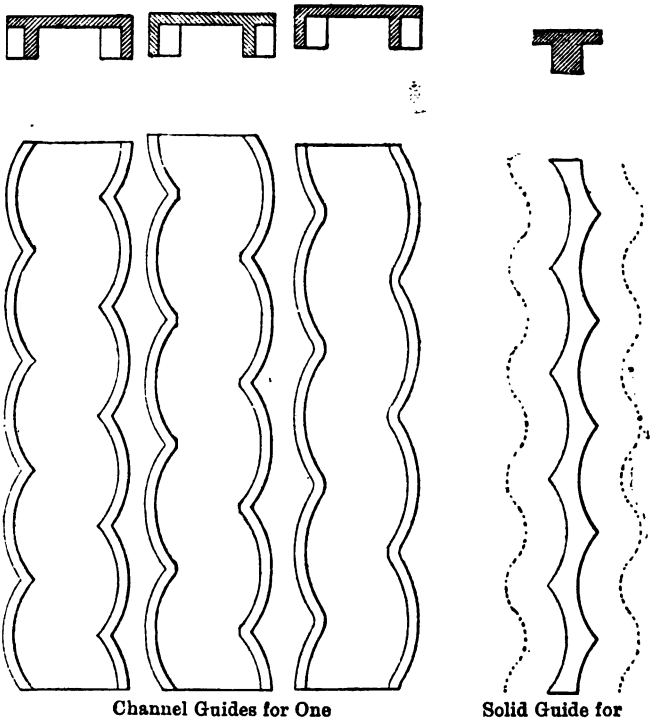
buckling strains on the side sheeting of an unsupported holder. If, however, these strains can be proved to be of no great moment, then Mr. Gadd will have shown how Mr. Webber's idea of no framing can be made practicable.



Channel Guides for One Tangential Roller.

Solid Guide for Two Tangential Rollers.*

FIG. 19.—LIVESEY'S TANGENTIAL GUIDES FOR GASHOLDERS.

Assuming that for single holders, or shallow telescopic ones, unsupported by guide-framing, the idea of holding the bottom curb to be successful, we have in the next place to find the simplest plan of effecting that object. We have Mr. Gadd's clever application of the screw or inclined guides; and I have now to introduce an upright guide to effect the same purpose. It is either made in channel form with a single tangential roller, or solid with a tangential roller working on each side. In the case of the channel guide, the roller must be carried on a stud unsupported at the outer end; but with the solid guide, the rollers work on pins supported at both ends—thus having the advantage of greater strength.

* The dotted lines show the paths of the centres of the rollers.

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The peculiarity of the guide consists, as shown, in alternate projections and hollows on the sides. The projections on one side are opposite to the hollows on the other, against which the roller or rollers work; thus compelling them to take a zig-zag course. This produces in the holder in its rising or falling a slight alternating movement on its vertical axis—turning, in fact, like a top on its centre, but only to a very small extent in one direction (say) to the right, when the action is reversed, and it moves to the same extent to the left; then again to the right; and so on. The projections may vary in size and shape; but here they are shown as equal to one-fourth the diameter of the rollers—say, 3-inch projections for 12-inch rollers—and as the zig-zag path is of exactly the same width as the rollers, there is thus 6 inches clear between the projections on the side of the guides, which may be used as a path for radial rollers if required.

The guides being fixed either to the side of the gasholder or to the tank, in exact correspondence, the closely fitting rollers must of necessity all move together in the same direction, and to the same extent. Consequently tilting is prevented; the bottom curb being held rigidly level, though perfectly free to rise and fall. The overturning force of the wind is resisted in an entirely different manner to that of ordinary framing. The rollers on the lee side hold the curb up, while those on the windward side hold it down; whereas with ordinary framing tilting is resisted by two or more series or circles of rollers at different levels bearing on the guide-framing. In one case the base is secured; in the other, the sides are supported. The difference, therefore, is radical; and it may bring Mr. Webber's idea within the range of practical engineering. Of course, the effect arrived at with the corrugated guide is the same as Mr. Gadd's spiral; and it is not my intention to disparage the latter, or to draw comparisons between them. If both accomplish the same object, it remains for impartial practical men to determine which is the more suitable for the purpose; and if any should prefer mine, they will not find that the protection it was necessary to obtain in the form of a patent will prove an obstacle to its adoption.

If either the spiral or corrugated, or both forms of guides prove effective, it will then no doubt be practicable to work single gasholders, or small and shallow telescopic ones of two or possibly three lifts, without guide-framing, as holders of this kind are proportionately much stronger than larger vessels—the sheeting being of about the same thickness in both cases. If successful, it will remove the objection to shallow holders; and in fact will make them both economical in construction and safe in working.

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Expense will be saved in the tank; while the holder of four, five, or possibly more lifts, with the cups at comparatively short distances apart, will be better able to resist the diagonal strains that tend to distort and buckle the sheeting if unsupported by guide-framing. For large and deep holders the utmost I expect from the new form of guiding is that, by reducing the strains on the guide-framing, it will not be necessary to increase its strength when leaving two lifts out of three or more unsupported. Beyond this, as the new guiding arrangements do not in any way affect or diminish the strains on the side sheeting of the part of the holder which is not supported by framing, the danger of distortion and buckling renders it impracticable to work the three lifts of a large and deep holder guided from the bottom curb only, without greatly increasing the strength of the side sheeting, and so adding to its weight and cost that all advantages would disappear and the balance be left on the wrong side. Let us hope that on this point there may possibly be a mistake; and that all the predictions and hopes of the enthusiasts will be satisfactorily developed in practice.

Discussion.

The PRESIDENT said the members had before them a novel theory in the matter of gasholder construction; and he expected there was not anyone there who was able to give them the result of any really practical experience upon this subject, except in the case of the Rotherhithe holder. There were, however, many present who would be in a position to criticize the matter from a theoretical point of view; and he was sure that they would have a good discussion, which would tend to enable them to come to a clear understanding as to whether Mr. Livesey's system could be economically substituted in place of guide-framing.

Mr. LIVESEY said he hoped every objection that gentlemen present could think of would be urged, as he was not himself particularly partial to the idea.

Mr. W. H. H. BROADBERRY (Tottenham) thought the thanks of all the members were due to Mr. Livesey for the able manner in which he had placed this question before them; but those who knew Mr. Livesey were not at all surprised at that. On the question of the method of guiding gasholders, he did not know that there was anything practical to be said upon the matter. It seemed to him that Mr. Livesey had mentioned all the points that it was possible to discuss. As to erecting gasholders without guide-framing, it really came to the question of cost. Personally, he could not at present see that there was much advantage to be gained by dispensing with the old-fashioned guide-framing, though he must admit that it was possible to improve the

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latter. The present method of guide-framing seemed to him to be very simple; and up to the present time it had proved efficacious. If, however, it was at any time necessary to build a gasholder where there was no room to put up guide-framing, then they could use one of the ingenious plans which they had before them—either Mr. Livesey's or Mr. Gadd's arrangement. Under these circumstances, there was no doubt that they would prove very useful; but it seemed to him that if they had room for a gasholder to rise, it only required a little more space for the guide-framing to be erected. He should have more confidence in the good old-fashioned guide-framing than in Mr. Livesey's idea. It appeared to him that if the strain was taken away from one place, it must be put on another—that was, on the sheeting and bottom curb of the holder. In any case, they would no doubt have to considerably strengthen the bottom curb; and on the question of dispensing with the upper guide-framing of a three-lift holder, it appeared to him that they would have to strengthen the curbs and cups to prepare for it. He did not know whether or not this was so. The question naturally arose, Where was the saving to come in? Unless they could show that there was to be some saving—unless they could show they would get more for their money—he did not see where the special advantage would occur. At any rate, on the question of gasholder building, they knew that there were really very few who would be able to try experiments in this direction. Mr. Livesey was rather a bold man, and no doubt he liked to depart from trodden paths. As a proof of this they had the experiment at Rotherhithe. This holder appeared to work very well; and he hoped it would continue to do so. He must, however, confess that, unless he saw something more than he had done up to the present, if he had to build a three-lift holder, he should run the guide-framing up to the top. If ever necessity arose to put up a holder without guide-framing on the outside, he would then consult either Mr. Livesey or Mr. Gadd, and see what they could do in the matter. He must acknowledge that he had a prejudice for the old-fashioned outside framing.

Mr. C. GANDON (Lower Sydenham) considered that the paper was a most important one. Personally, he had very little to say upon the matter; for as he had not had any practical experience in building holders without framing, it could only be pure speculation. He read with considerable interest, and he hoped with some little advantage, the admirable articles, to which reference had been made in the paper, that appeared in the *Journal* by "Theory and Practice." Although he had had some doubt as to the possibility —or desirability, at all events—of attempting to work any portion of

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a gasholder without guiding it, he must confess that these articles convinced him that it could be done, at least so far as the upper lift of a three-lift holder was concerned. If any gentleman present had not read the articles, he would strongly advise him to do so; and he trusted that the suggestion contained in the paper, that they should be printed in a separate form, would be carried out, for they were the most interesting contributions they had on the subject. But these ideas—both Mr. Livesey's and Mr. Gadd's—were entirely different from what he had gathered from the articles. That any one could raise the upper lift of a three-lift holder without guide-framing was, to his (Mr. Gandon's) mind, satisfactorily proved by the articles, and still more satisfactorily demonstrated by the Rotherhithe experiment. He had seen the holder there at work and fully inflated; and it seemed to him to be perfectly safe. As to these spiral or zig-zag guides, he was bound to confess that he did not know how they acted. Mr. Livesey had mentioned the matter to him some weeks previously, and he had since read the paper; but still he did not quite understand it. He could not see what there was to prevent the holder tilting or jamming. With Mr. Gadd's spiral guiding, he could see it more clearly. Possibly it was only his obtuseness that prevented him comprehending the principle. Mr. Livesey's plan was probably a modification of Mr. Gadd's spiral; but he certainly could not understand how it would prevent tilting. There was also this question for consideration—How far would they have to strengthen the holder to resist the strain which might be thrown on it by doing away with the framing? One difficulty in designing a large gasholder was to prevent it from causing too great a pressure. If they had to strengthen the holder, they would have to put more material into it in order to resist these strains. He did not therefore see that much economy would arise. He fully shared Mr. Broadberry's views in this respect, for he had a conservative feeling and a singular affection for the old-fashioned guide-framing; and if he (Mr. Gandon) had to put up a holder of any considerable dimensions, he should adopt the old method of guiding it. He should like someone else to make an experiment with the new style first. He thought the plan was feasible, and there seemed to be a considerable amount of theory to back it; but he should continue to prefer guide-framing until the new system had been proved. He saw in the illustrations that the projections on the guides were angular. Would it not, he asked, be better in practice that they should be rounded off?

Mr. LIVESEY: You will see that we have experimented with one that has been rounded.

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Mr. GANDON: Partially rounded; but he thought it might be more so. He could only offer his own views upon the question before them; and, in conclusion, he would again say that until the idea was proved, he should stick to the old framing.

Mr. C. E. BOTLEY (Hastings) said that the same ideas had occurred to him which had been expressed by Mr. Gandon. He also thought there would be a tendency for the holder to jam or tilt with the proposed plan of guiding it. He also asked Mr. Livesey to explain the working of his single tangential roller in the guides. If this system would reduce the cost of erecting gas-holders, it would be a very great boon. But when they knew that it would be necessary to considerably strengthen the bottom curb and the holder altogether, it was trying an experiment which might not succeed, while at the present time they had a fairly cheap and satisfactory way of guiding holders. What diameter holder, he asked, did Mr. Livesey or Mr. Gadd say could be worked upon with this system of guiding? He had just been designing a new three-lift holder of rather small diameter (about 100 feet), as they had not much ground available on the site; and he was considering whether he would not do without the framing to the upper lift. But he thought it would not be well to risk it for so small a holder. He should like to know whether or not Mr. Livesey's or Mr. Gadd's new system of guiding would be applicable to a holder of small diameter.

Mr. W. D. CHILD (Romford) remarked that Mr. Livesey had taken those present into his confidence so thoroughly in regard to his invention, that he (the speaker) thought it was only right on their part to return the compliment by expressing the slightest difference of opinion which they might have regarding the matter, so that one and all might have the benefit of it. They might be in error; and the correction of it would set them right. There was one thing they had to look at in the construction of holders on this principle. Taking it simply as a single-lift holder, he did not see exactly any reason why the strength of the holder should be in any way increased to deal with a question of this description. Mr. Livesey was attempting to control the movement of the holder by gripping the bottom lift; and therefore the sides, it appeared to him, would be entirely in tension. The only thing that occurred to him was whether the projections of the guides were not too sharp—that they would give, as it were, a jerky movement to the holder in rising and falling, and rather a tendency to set itself fast. If it would work without any difficulty and with smoothness, it appeared to him that the system would effect a considerable saving, in the cost of both the holder and the

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tank, because anyone who had had experience in excavating tanks must have seen that the cutting away of the extra diameter where the piers were required, was frequently a source of great difficulty, and was more likely perhaps to bring about a fall of earth than when making a regular circular excavation.

Mr. W. H. Y. Webber (London) remarked that there appeared to be some little hesitancy on the part of the general body of members to discuss this question. He thought this might be largely due to the fact that there was some misapprehension in the minds of a good many as to what was the exact scope or object of the various ideas put forward. When trying to imagine how a gasholder could be erected without any guide-framing at all, it was his idea that the real object was the pursuit of truth with regard to the principles governing the stability of gasholders. The first consideration was not so much whether or not they were going to save a few pounds in the construction of a gasholder of given dimensions. They wanted to get at the truth of the conditions governing the stability of the holder; and then if they once found this datum, it followed that they could go on building holders as high and as large as they liked. Then the question of economy came in. Mr. Botley had made an inquiry in reference to small holders; and he (Mr. Webber) might remark, with regard to small holders, that it was easy to try experiments with them, although the saving might be comparatively slight. He would ask those present to carry their minds a little back to the time (say) when gasholders were always built with very massive cast-iron columns—some fluted and gilded, and all that sort of thing; and the only idea of holding the columns up was an ornamental horizontal girder at the top. The natural consequence of this order of ideas was that there was understood to be a limit in the size and height to which holders could be safely carried. The result was that sometimes when additional storeage was wanted, extra ground had to be bought, and another holder put up; whereas if inquiry had been more thorough into the conditions of stability, the existing holder would have had another lift, or even two or three lifts, added. He did not know how many lifts Mr. Livesey thought his holders would bear; but it appeared to him (Mr. Webber), judging from the way in which he was going on, he would make them something like one of those tourists' telescopes of manifold slides, which could be drawn out to an extraordinary length. There was, of course, a good deal of criticism, on suggestions of this kind which was—if he might use the term—comparatively cheap. It was very easy for anyone to say they did not like this sort of thing, and that

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they would not care about being the first to try it. They would be without gas altogether if everyone had always gone to work in that spirit. With regard to the principal saving effected by the adoption of any successful method of doing away with the superior framing of gasholders, he thought Mr. Newbigging's paper read before the Manchester Institution should be mentioned in connection with any discussion of this subject. He considered that this paper very fairly showed where the economy was likely to come in. A special point was the saving that would be effected in regard to holders intended for export. The matter had only to be mentioned to show what a wonderful difference there would be in this respect, especially if they had to send gasholders inland in places where only horse or caravan carriage was available. A holder of any size could be despatched to any place with comparative ease, provided there was no guide-framing to carry with it. He agreed with Mr. Child in the opinion that there need not be any necessity for greatly increasing the strength of gasholders. If they were to be stayed only from the bottom, it might be so; but this was one of the points which had to be proved. The diagram which Mr. Livesey had included in his paper, from those very able articles to which he had referred so abundantly, certainly showed that the stresses increased as the guide-framing was cut down; but he did not think they showed that the stresses surpassed the point which they might be permitted to attain. He (Mr. Webber) was not altogether certain on this matter. The stresses would be much greater, but were they excessive? He did not think they were; and he considered that Mr. Child was quite right on this point. The matter was entirely open for discussion now. Nobody could say very much about it one way or the other. Whether or not the thing succeeded, there were numbers of gas managers who would not reconcile themselves to it, and who would continue to profess that they would be able to retire to rest more comfortably if they were able to rely upon the old guide-framing. Some of them might be disposed to laugh at this timidity. But he thought there was quite as much reason for it as some engineers had for not believing in telescopic holders at all; and it was notorious that there were some clever engineers in the world who had not been able to reconcile themselves to the idea of a telescoped holder. Meanwhile, however, he protested against suggestions of this or any other novel kind of thing being condemned by the mere prejudice of those who could only say they did not like them, and would be more comfortable under an old system.

Mr. F. S. Cripps (London) said he was pleased that he had been invited to the meeting, for he was glad to have an opportunity of

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hearing Mr. Livesey read his paper. It was certainly a very practical paper—at any rate what the author had said was put in a very practical and clear way. Mr. Livesey had stated at the commencement that a copy of the paper had been supplied before the day of meeting; but unfortunately it had not been sent to him (Mr. Cripps), or he might have criticized it to greater advantage. He agreed with practically everything that Mr. Livesey had said; but the question of the zig-zag kind of guides was one that required to be very closely looked into. If he might make a criticism, it seemed to him that the holder would have a jerky motion in going over what perhaps he might call the "corners" of the guides. He would therefore suggest that these should be made easier. Mr. Gandon had alluded to the same thing, but in a different way. Presuming, however, that they could get a gasholder perfectly level, and cause it to rise perfectly level throughout, what had they to gain by it? This system of constructing gasholders without any guide-framing might possibly be more economical in first cost; but that would depend upon the quantity of material they were going to use. If they increased the strains coming upon the holder, they must increase the weight of metal they put into it; and this would counterbalance some of the saving obtained. The question was, In doing away with the whole of the guide-framing, how much were the strains increased? Mr. Webber and Mr. Child did not think that the strains would be very much greater; or, in other words, that the extra strains would not make it necessary to put much additional material into the holder. He (Mr. Cripps) could not altogether agree with them. Mr. Gadd had on a previous occasion said that the sheeting of a gasholder was of no importance at all as regards resisting the strains—that it depended entirely upon the framing. Mr. Gadd likened it to an umbrella, the cover of which might be thrown away, trusting to the framing to resist all the strains. Taking it for granted, then, that the sheeting could be disregarded, as far as resisting the strains was concerned, What had they left? A fragile frame, consisting of a series of horizontal rings one above the other (curbs, cups, &c.), and connected together vertically by a number of vertical posts (guides) all round the circumference. Now, even supposing they looked upon each of the horizontal rings as incapable of distorting out of shape, and that they would retain their circular shape under every condition, the whole frame was not even then by any means rigid; it was unstable, because it was made up of a series of parallelograms, which could all rock over sideways together, without altering the lengths of their parts. The only thing which prevented them doing so was the

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assumption that they were perfectly fixed and rigidly attached at the base, and that the holder was considered, for argument's sake, to be as good as standing upon solid ground. In order to be rigid, it must be a series of triangles; and to get this they must introduce into the gasholder a system of diagonal ties between the vertical posts all round the holder. This could not be done, as the space between the sides of the various lifts would not admit of it. So they must depend upon the sheeting fulfilling the function of the diagonal ties. But the sheeting could not do so, owing to its curved form between the stays, because under diagonal stress it would at once straighten across the corners, instead of resisting the force. It came to this, then—that they could not have diagonal ties, and they might not rely upon the sheeting. Therefore, the simple framework had to take all the strains. To show how incapable it was of doing so, he would take an actual example. Take a gasholder 200 feet diameter and 120 feet high. The size of the guides in the outer lift would be about 6 inches by 3½ inches by ½ inch channel iron, or (say) 8 inches by 2½ inches by ½ inch; and there would be (say) 44 in the circumference. Now, as they assumed the horizontal cups, curbs, &c., to be rigid rings, incapable of deformation, the force (due to wind pressure) would be equally distributed over the whole of these vertical posts, and would tend to break them all short off at the base. The breaking load of all the 44 channel-guide, 120-feet high cantilevers, taken together, was only about 13 tons (uniformly distributed). The safe load would only be one-fourth of this—say, 3 tons. Now, no one would contend that the wind pressure on the side of a gasholder 200 feet in diameter by 120 feet high did not exceed 3 tons. Why, at 10 lbs. per square foot only, it would be 10 tons! Therefore, they must depend upon something else beyond the guides, or increase their strength, which meant weight. If they put in Mr. Gadd's diagonal guides, they would probably in a measure act like diagonal ties; but they were curved, not direct-acting, and would need vertical posts as well to make the bracing continuous. Otherwise it would be like a girder with the lattices all one way. He thought that even then there would be a good deal of twisting and distortion of the gasholder bell, especially when they considered he had been treating of only one set of strains upon the holder. There were other matters which could not be ignored; and even what he had already dealt with were based upon such very favourable conditions (perfectly rigid cups, &c.), by no means tenable. It was forgotten that the higher they went into the air, the greater were the strains. Mr. Child said it made no difference how high a gasholder was.

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Mr. CHILD said he should like to disclaim this at once. He went straight to the principle of guiding a bottom lift of a holder the whole way. He was not speaking specially of a one, two, or three lift holder.

Mr. CRIPPS said he had misunderstood Mr. Child. If they did away with the guide-framing to a single-lift gasholder, they increased the strains on the bell fourfold; with a two-lift holder, they would have 16 times as much strain; while with a three-lift holder, without guide-framing, it would be 36 times as much as in an ordinary single-lift holder of the same diameter and depth of lift. The lower lift of a gasholder had the most strain; the next, less; and the top one, the least of all. No one who had advocated the total abolition of guide-framing had as yet shown scientifically that the guide-framing could be abolished altogether. Mr. Livesey had abolished it for only one lift—viz., the top lift of the Rotherhithe gasholder; but he had not gone so far as to do away with guide-framing entirely in a three-lift holder.

Mr. LIVESEY: And I am not going to try.

Mr. CRIPPS (continuing) observed that before the system of no guide-framing was really brought out, it should be shown theoretically and scientifically that it would work—not simply brought forward and said that it could be done. It must be proved, just as he could prove to the contrary. When this was done, possibly they might launch forth into making gasholders without guide-framing; but not till then.

Mr. CUTLER (London) expressed his satisfaction at having been invited to be present to hear this interesting paper of Mr. Livesey's. Of course, the idea of erecting a gasholder without guide-framing was quite contrary to the traditions of the gas engineering profession, and there was no experience to bring to bear on it. It did not require any argument or mathematical investigation to prove that if a holder had to rise and fall without guide-framing, the strains which in the ordinary way were taken up and resisted by the framing, would have to be borne by the holder; and it seemed to him that they needed proof to show the advisability of putting this additional work on a vessel designed for a different purpose than that of resisting such forces—viz., that of containing gas; and therefore of necessity it should be kept in a condition not likely to allow of its escape, and therefore kept as free as possible from unnecessary straining. The experience of the past proved the advantage of framing; and for his part he was unable at present to see any possible advantage in attempting to do away with it. Mr. Livesey had referred to the experiment at Rotherhithe; but he (Mr. Cutler) could scarcely agree that the fact of this holder

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working all right demonstrated the advantage of doing away with the upper portion of the framing, although it certainly proved the possibility of so doing. Was not the holder and its framing exceptionally strong? and was it proved that the additional strain coming on to the bell might not be detrimental to it as a gasholder? With regard to the idea suggested in the paper, he had not had an opportunity of seeing the paper before he came to the meeting; but certainly he was exceedingly doubtful as to the successful working of such a gasholder. Its condition had been described as if it were locked or fastened at the bottom, and thus unable to tilt, and as if it were on the solid ground, when, of course, it could not be made to tilt. But, he asked, was not such an idea contrary to the proper conception of what a gasholder is—viz., a bell freely floating on the gas which it contains, and giving to the gas a pressure equal to its weight. If the holder became locked at the bottom its weight would be more or less supported, not by the gas, but by the slanting guides on which it worked; and what sort of influence would this have on the pressure-gauge? He should be glad to have some explanation on this point. One portion of the gasholder—viz., the bottom curb—he was glad to observe was now receiving more like the attention it deserved. Engineers had hitherto seemed very much to overlook the importance of this member of the structure. For his part he did not remember ever to have seen a bottom curb really of sufficient strength in large gasholders. In his opinion, too much importance could not be given to the bottom curb, and to the lower guide-wheels, which should always be carefully adjusted, and receive much more watchfulness than was frequently the case.

Mr. W. Gadd (Manchester), on the invitation of the President, said he found it was somewhat difficult to speak generally upon the paper before them. He did not know that he ought to do this under present circumstances, because it would not be necessary for him to deal with the special propositions put forward by Mr. Livesey; inasmuch as there had been a great amount of discussion thereon amongst the members. He would like to say one thing, however, relating to his own experiments. He had tried the effect of his spiral guides going short distances and returning and spiralling the opposite way. It seemed to him to be something very like what Mr. Livesey proposed to do. He showed a modification of this idea in one of the models which he exhibited at Doncaster at the meeting of the Manchester Institution. Those who were present would remember that the lift travelled in one direction——

Mr. Livesey: But each lift travelled all its height in the same direction.

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Mr. GADD said this was so; but it was a modification of the same idea as was shown at Doncaster. He found that there was a little jump or jerk; and he took it that it was accounted for in this way: However slowly the lift might be going, there was sure to be a certain momentum acquired. This had to be overcome; and when they came to the return, it had to be acquired in the contrary direction. To go to the more general principles, which had been mentioned by the various speakers, of dispensing with guide-framing, he thought, with all deference to those gentlemen who naturally felt that they would like someone else to try the experiment—they all liked this—it was, at any rate, not the way in which important improvements had been effected. The great improvements they had seen in the past had always to be brought about by someone making the trials and risking something. Of course, it would be quite improper, as Mr. Cripps had pointed out, to undertake a practical experiment without knowing something about the theoretical stresses, and satisfying one's self beforehand that there was a firm foundation to build upon. He had listened very attentively to the part of the discussion in which Mr. Cripps engaged, because he had a great respect—to put it in the mildest form—for that gentleman's opinions and for his knowledge of such matters, which he (the speaker) recognized as very considerable; and therefore Mr. Cripps would probably excuse him for slightly dissenting from his description of his (Mr. Gadd's) views. It was perfectly true that he tried to liken a holder to an umbrella covered with light canvas; but it was also perfectly true that he (Mr. Gadd) did not exactly say that he would let the sheeting go to the winds. What he did say was that, in designing a holder, it was wise to have the framing sufficiently strong to carry the sheeting, which nevertheless had its own work to do, and was, after all, most necessary to the strength of the structure. It seemed to him that a holder without framing was subjected occasionally to all possible strains at once. This would be dangerous. First of all there was the strain of distortion—that was, as he took it, the tendency to get out of true shape. The second, which to his mind was the most important thing to be considered, was the possibility of what he would call the shearing strain—that was, the possibility of bending over. Now, if the holder would resist this shearing strain, he contended that it was strong enough for any pressure to which it could be subjected, because he believed if it would resist the shearing strain, it would resist distortion; for the simple reason—that at present a gasholder was subjected to the chance of distortion, though it was held against the guide-framing, because if there was power enough in the wind, it surely went

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without saying that it could crush up one side against the guide-framing and thus distort it. Now, if it was at present strong enough to resist this strain, it would be strong enough, under any circumstances, without the framing, to resist distortion *per se*. Then came the necessity for resisting the possibility of shearing over. So far as the comparison of a holder with its edges resting on the solid ground went, the proposal he had made—of spiral framing—did compare therewith, to this extent, that the holder was held at its edges, and kept horizontally, the edges firmly and solidly gripped at every possible height as it ascended or descended. It therefore appeared to his mind that—he did not purpose going into any of the minor details—the only possibility of destroying a holder was by shearing action, because it was impossible to move it out of the horizontal without breaking the bottom rollers or guides. His holder worked equally well with three rollers as with six or more. So long as there were three sound bottom rollers—not necessarily in an equal sided triangle—his holder would work up and down all right. If the present make of holders was not sufficiently strong to form in themselves huge cantilevers of sufficient rigidity, they would require to be strengthened up to that point; but not necessarily by adding weight. As regards weight of material, it was in the main quite strong enough. He was perfectly free to admit that it might be necessary to alter the form or disposition of the material somewhat for the purpose. Mr. Newbigging, in his paper, suggested that the stays should be in the triangular form, at or near the bottom curb of the holder. This, he thought, would give the requisite strength; and, furthermore, the spiral guides necessarily formed an arch or bow which must strengthen the holder against distortion. He was convinced that if it could be demonstrated that a stable holder could be made, the economy would necessarily be great; and this had been incidentally shown by one of the previous speakers, when he mentioned the cost of the foundations of the piers, and so forth. This was a very important matter indeed. They had, by the system proposed, a simple, plain tank, without counterforts. The guides could be either built into the tank or be attached to the sides in any way which the engineer designing the tank thought best. If it was true that something like 50 per cent. of the weight could be taken out of the total structure, it must, of course, make a large reduction in the cost. He took it that this was a question which must not be lightly disposed of—that this possible saving could not be ignored. He did not know that there was anything more he particularly desired to say on the subject. He would only mention that the two models of holders

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on his system that he had in the room were not so perfectly constructed as he should have liked them to be. However, they were sufficient to show how the system worked. With regard to the fitting of the rollers on the guides, he had purposely left them very loose; his object being to show that, with loose-fitting guides, without the necessity of anything tight at all, the thing would work. Of course, in practice on a large scale, they would be made just as tight as was found necessary for the purpose.

The PRESIDENT said he noticed Mr. Henry Woodall, the President of The Gas Institute, in the room; and he was sure all present would be pleased to hear a few remarks from him on the subject under discussion.

Mr. WOODALL said he had only just come from Birmingham, and had not had the pleasure of hearing the paper. He was not prepared to say much of consequence on the question, because, as they were all aware, he had been out of office, and had not had any opportunities of inquiring into the particular aspect of the question which was at the present time engaging the attention of the meeting. Although he could not offer any technical suggestions, he could speak of his experience with gasholders, and give one or two illustrations which would have some interest in connection with this question, and might possibly be of some value. Looking at the matter from the light afforded by his experience, he might ask whether it was not a fact that the holder often supported the framing, rather than the framing the holder. That the framing of holders had ordinarily been built very much stronger than was needed, he had been convinced for many years past. He was the more assured of this from an accident which happened to a large two-lift holder at Leeds, when, in consequence of the upper lift being frozen (gas being delivered from it at the time), the holder fell with such a crash that the sudden vibration caused a fracture of every one of the 16 columns, 8 feet in diameter. He applied four straps of wrought iron to each column, each having two bolts above and below the fracture; and in this way the holder, 150 feet in diameter, lasted several seasons—until he had it converted into a three-lift one. This was only one of two or three cases of the kind he might mention, though perhaps not so distressing. The holder only cost £5 for patching.

Mr. LIVESEY asked if the holder had diagonal bracing.

Mr. WOODALL replied that it had not. They were cast-iron columns, with two tiers of girders. Then in course of time he dispensed with the framing, and used very light wrought-iron framing. These holders had been characterized as "gossamer" structures, that would not stand a gale. It so happened that the

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first of the six holders he put up was met by a very severe gale before half the bolts were tightened, and it stood perfectly. If any of the gentlemen present went to Leeds, they would see some of the lightest possible structures. He had never heard of the slightest difficulty with them, though there were ten three-lift holders there.

The PRESIDENT said the discussion had been very full and interesting. Some of those who had spoken were very conservative, and some very radical; and he supposed that between the two they would find the answer to the great question before them. It seemed to him, as Mr. Woodall had said, that they had in many of the gasholders round and about them too much work in the portion of the structure which held the holder in position. On the other side, he thought that when they came to construct gasholders on the system demonstrated by Mr. Livesey and Mr. Gadd, they would require to have a great deal more strength in the lower part of the structure.

Mr. LIVESEY, in reply, said that he had been extremely interested in the discussion that had been carried on so ably by so many of those present; and he really felt there was very little to say. Perhaps it would be better to take the remarks *seriatim*. Mr. Broadberry thought it would be necessary to strengthen the cups. Well, he did not think the use of tangential rollers had been sufficiently appreciated. By their use, the strain was applied in such a way that the cup was in the best position to resist it. Where they had radial rollers, they by their bearing on the guides tended to push the cup inwards; but with tangential rollers, the stress was in a direct line with the cup in its strongest position. That was a source of additional strength, or rather it removed a cause of weakness. In regard to their friend's anxiety as to the strength of the unsupported holder, the experience of the President of The Gas Institute seemed to show that the framing used in years gone by had been stronger than was necessary. That extraordinary experience of his showed that a holder would work safely with very weak framing indeed; and therefore, if they were to assume that by the abolition of framing they might have to strengthen the holder, it did not at all follow that they must put as much strength into the holder as was now found in the framing of ordinary holders. It was shown by experience that the framing was stronger than was necessary. Mr. Botley raised an important question about the tilting or wedging; and he wished to know how these new guides of his worked. It was a difficult matter to explain how the thing worked; it was necessary that each one should think it out for himself. Of course, in

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practice, they would have a series of these guides extending all round the tank—perhaps a score or more, and all placed, as he had said in the paper, in exact correspondence. Thus, the projections and hollows of all the guides would be exactly at the same level. Consequently, when the holder was going down, supposing the rollers to be in the top hollows of the guides, all the rollers must move in the same direction, (say) to the right, until they passed the projection. They then moved to the left, then again to the right, and so on. Of course, it had to be proved whether the thing would tilt or wedge. He had been experimenting, but unfortunately had not had time to carry out the experiments thoroughly; but so far as they had gone it seemed that, while tilting to the extent of an inch or two might take place, in practice there was no danger of wedging. He was about having a model made. If it succeeded, he would show it at the next meeting; and if it failed, he would explain why it had done so. A radial roller would work straight up these guides in the clear space of 6 inches in the middle between the projections; but as it might possibly catch against the projections, they could have a channel-shaped groove or recess cast in the centre, which would provide a suitable path, 6 inches wide, for the radial roller. Perhaps he had better say that he was not going to recommend anybody to adopt this system. As was well put by Mr. Webber, this was a discussion on a principle; and what they wanted to do was to settle sound principles. Mr. Botley's question as to the size of holder adaptable to the system referred more to doing away with the upper framing, or employing a shortened framing. He (Mr. Livesey) did not see why that should not be applicable to gasholders of any diameter; and he was not at all sure that they would not be safer for small holders than large ones, because small holders were relatively stronger than large ones to resist distortion. Mr. Child said there was no reason for increasing the strength; and Mr. Cripps had dealt very exhaustively with the matter. For a single-lift holder, he, like Mr. Child, did not think it would be necessary to increase the strength of the sides at all. He must say that so far Mr. Cripps had proved his point, that to leave two lifts unsupported would cause greatly increased strains on the sides, and to leave three lifts unsupported would be quite out of the question. He could not but believe that the strains would be very considerably increased on the side sheeting if entirely unsupported by guide-framing. In this connection he could not do better than again recommend those who had not done so to study the articles by "Theory and Practice." He must make one remark on what had been said by Mr. Webber. He said that Mr. Newbigging's

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paper ought not to be passed by without mention. With that he (Mr. Livesey) quite agreed. The paper was a very interesting one indeed, and dealt with a part of the subject which was of great importance. In that paper was shown the proportion which the framing bore to the bell; and hence the argument—seeing that the framing bore so large a proportion to the weight of the holder—if they could do away with the framing, there would be a considerable saving effected. Mr. Cripps asked whether it would not be better to make these projections easier or more rounded in his (Mr. Livesey's) guide. In one of the sketches in the paper, they were shown easier; but that was really a matter of experiment. It had to be found out what kind of curve in the guide would be most suitable for the purpose. The specimens handed round for inspection merely showed the principle. Mr. Cripps spoke about the possibility of a jerky motion with this guide. Possibly there might be a slight jerky motion, but that also had to be proved. He did not think there would be any difficulty on this score whatever. Mr. Cutler had spoken about the Rotherhithe holder being a holder of great strength. It had, he confessed, heavy guide-framing; but he did not call it a strong holder at all.

Mr. CUTLER: The bell of the holder is strong.

Mr. LIVESEY: The holder has strong roof framing and sheeting; but it is not uniformly strong. But the guide-framing was not at all strong, apart from its great weight, to resist the strains that might be supposed to come upon it. He was sure that if they were going to build a three-lift holder, and to stop short at the second lift, they would put up a much stronger framing at less cost and weight. As he had explained, the holder (imagining it to be standing on the ground) with the new form of guides, was held down at the sides, and was supported from its crown by the pressure of the gas on the crown; and by Mr. Gadd's plan and his own, it was held down at the sides. If Mr. Cutler was right when he spoke about the bottom curbs being weak, it was a difficult matter to make a bottom curb very strong, as its width was restricted. But the same object could be obtained by increasing the number of rollers or points of support, or by using tangential rollers. By doubling the rollers, and thus reducing the distance between the bearings by one-half, probably the curb would be strengthened fourfold; and, paradoxical as it might seem, they might thus reduce the weight of the curb very materially, and yet increase its effective strength. He had not any comment to make upon Mr. Gadd's remarks; but he must say he did not think he had answered Mr. Cripps in relation to the question of distortion of the sides of the holder. He

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spoke of the shearing action; but it appeared to him (Mr. Livesey) that the wind-pressure on the holder must tend to distort and buckle it; and until that was proved not to be so, he would be a very rash man who would build a three-lift holder without any framing at all. Another thing occurred to him. He did not think the sides of the holder were sufficiently rigid to fix the guides to. They might well be fixed to the tin sides of a model; but that was not like a gasholder. There was no relative proportion between the two. If they were to fix spiral or his guides to the thin sheeting of a gasholder, and depend entirely upon them, it would not be sufficiently rigid to resist the strains that came upon it. If these guides, on the other hand, were fixed to the tank, they had there a perfectly rigid support; and the rollers on a strong bottom curb could not disturb the guides. But if they fixed the guides on the sheeting of the holder, he was very much afraid that it would spring and give way under the strains that would come upon it in a holder entirely unsupported by guide-framing. His idea was this: As to doing away with the framing altogether, he had never thought of it; and from all he had seen and heard, he did not think it would be advisable or practicable. The more he thought of it, the less he considered it would be safe to abolish the framing altogether. He should think it would be practicable to build a three-lift holder with guide-framing one-lift high, and to adopt for it Mr. Gadd's or his own guide. Of course, he should naturally prefer the latter. The inner and second lifts would be guided till they cupped by radial rollers working up the centres of the guides; and with two series of tangential rollers on the outer lift—one on the cup and the other on the curb working in the corrugated guides—he thought the bottom lift would be perfectly rigid and safe; and the two upper lifts, if they were strong enough to resist the distorting action, would also be perfectly safe. That he might tell them, was the utmost to which he thought it would be safe to go. He was much obliged to them for the patience with which they had listened to the paper; and he could only hope that the result would be that it would help to settle what were the true principles of gasholder construction.

Mr. W. E. Price (Hampton) next read the following paper:—

SOME HINDRANCES TO THE SALE OF GAS.

Given an efficient plant, and the wherewithal to work it, a gas engineer, with a sound knowledge of gas making in all its branches, is quite prepared to produce as much or more gas than may be

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required; but his energy is far from being less needed when he has delivered it into the gasholder. He has then to put forth his best efforts to find what most commercial men have more or less difficulty in finding—a ready and increasing market for the article which he has manufactured.

Like with most commodities or necessities, the demand for gas is regulated by its comparative cost to the public, taking into consideration its advantages and disadvantages compared with that of other illuminants; and we, as commercial men with an article to sell, ought to leave no obstacle in the way of preparing a smooth path for the use of gas. We must not forget that there are other means of obtaining artificial light—from the tallow dip to the electric arc; and if we wish to see the demand for gas increase, we must remove all real obstacles to its use. Wherever we see a supposed advantage in a rival illuminant, we must endeavour to remove our corresponding disadvantage; so that the public may not give two thoughts to another light in their necessary and wise considerations.

Let us suppose for a moment that we know nothing of the manufacture of gas, but are desirous of becoming consumers of that article. The first obstacle that "ruffles our feathers" on applying at the gas office is the demand for a deposit. On principle, we object to the prepayment of a certain sum of money as a bond of our honesty; or, even if we manage to put up with that, we think that it is only reasonable that interest should be paid on the money deposited, which, I believe, the majority of companies refuse. No! Deposits, especially when demanded in an arbitrary manner, and with much red-tapeism, cause more dissatisfaction against gas companies than any other item in their dealings. Cannot we dispense with deposits in the majority of cases? The method I have adopted for some time past is to inquire of the applicant the company who last supplied him with gas, and then to make inquiries of that company as to whether the said person may be depended upon for the due payment for the gas consumed by him—not forgetting to enclose a stamped envelope for a reply. I do not think there is a manager to be found who would object to give such information under the circumstances. If the answer to the inquiry is not satisfactory, then is the time to require a deposit or some other form of security.

The next more or less heavy expense which a consumer has to bear is the whole or part cost of laying the supply-pipe from the company's main to the meter. This, in my opinion, ought to be borne by the landlord, as it is obviously to the benefit of his property and future tenants when the gas is laid on. The cost of

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fixing the meter is rather a different matter, and is a fair charge to make on the consumer; seeing that it is for his use only. But in this case, as also in that of services, the cost price only should be charged. A gas company should not seek to reap much or any profit from the actual connection of a house with the mains, as all charges of this class are obstructions and detrimental to the use of gas. Let a fair interest on all initial outlay be taken into consideration, when the selling price of gas is decided upon. This will probably only amount to a penny or so per 1000 cubic feet, which does not appear much in this form, especially when new consumers are reminded of the great advantage of being relieved of all primary outlay. In isolated cases, where it would be unwise to maintain the present charge per 1000 cubic feet on this account, the method now being tried by one of the London Companies in reference to internal fittings—viz., a weekly, monthly, or quarterly rental which is a fair interest on the outlay of providing a house with gas-fittings—might be extended to the external pipes.

The next item we have to consider is meter-rents. This is another source of dissatisfaction with consumers. Many have been the emphatic opinions expressed to all of us of the unfairness of this charge, especially in the case of old consumers, who have perhaps paid rent for their meters for 15 or 20 years. The reminder that even a gas-meter will not last for ever is not always convincing. The average consumer does not see, and cannot be made to understand, why he should pay rent for an instrument which he has not the least interest in having fixed at his house. All present know the prejudice of the public against gas-meters. The majority look upon them with great disfavour as one of the necessary evils of civilization—in use, only to be distrusted; out of use, nearly as bad. Unreasonable as we know this opinion to be, still we have to deal with it as it is; and our endeavour ought to be to disperse the idea in every possible manner. Experience has proved that the abolition of meter-rent will do this to a great extent; as with the application of gas to a house, a fair interest on outlay for meters could be charged on the selling price of gas.

Having laid on the gas for a new consumer without saddling him with any serious initial outlay, we find that our troubles are not over. Before long, we shall perhaps receive from him a complaint that the light is very insufficient and far from good. We call upon our friend; and, as we anticipated, we at once discern the cause of the complaint—bad fittings and worse burners. And what an extraordinary amount of reasoning will an average consumer listen to before he will believe that your accusation against his fittings is the cause of the complaint. He will not be

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convinced until you have found a bracket that will pass sufficient gas, and have fixed to it a burner which is suitable for the quality of gas supplied and the quantity required. Then only will he believe that the fault lies in his fittings and not in the gas. We have all been astounded at the miserable class of burner often used —some actually being new, or nearly new—which are entirely unsuited to the quality of gas supplied. These are generally fixed with the idea that their use will have the effect of reducing the gas bills; whereas we all know that the reverse is the case. To make matters worse, unscientific inventors are continually placing on the market burners of supposed remarkable economy, which, in reality, are nothing more nor less than mechanical means applied to unsuitable burners, with increase of cost and disfigurement of the flame, to secure a result obtained and generally surpassed by the use of an ordinary burner of suitable size. I am a strong advocate of governor burners. They are cheap, and burn the gas under the most favourable conditions, always giving a steady and uniform light, under the usual variations of pressure. I think the action of the gas company I have referred to is a step in the right direction—supplying and fixing suitable fittings and burners in the consumer's house at a weekly or quarterly rental; and I hope that it will be attended with success, and that their example will be followed by other companies who wish to maintain good relationships with their consumers. We shall then be able to see that consumers are supplied with pipes, fittings, and burners suitable for their requirements, and thereby give satisfaction.

We have often to listen to, and successfully combat, many more or less serious objections to the employment of gas. Many people complain of the injury to plants and health; and that the atmosphere of rooms in which it is used soon becomes unbearably oppressive compared with rooms where other means of illumination are used. This is no doubt a fact in very many cases; but is it not rather a point in favour of gas than otherwise, inasmuch as it soon discovers those rooms which, through bad or complete absence of ventilation, are not fit for human habitation? Those who make this complaint, and declare that previous to the use of gas no such oppressive feeling was experienced, forget that they are now using perhaps three or four times the amount of light they were contented with when employing oil-lamps or candles, and that they are now not only illuminating the table they are sitting at, or the book they are reading, but are enjoying the pleasures of a room well-lighted from floor to ceiling. The adoption of gas has unpleasantly reminded these people that the rooms which they have been using are nothing but inverted receivers

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of carbonic acid and other deleterious gases given off by the occupants of, and illuminating agents in the rooms, with perhaps a few outlets in the form of cracks in the doors and windows. These promiscuous outlets were sufficient to prevent any oppressive feeling whilst an isolated light was being used; but when universal illumination is adopted, the unscientific nature of the ventilation becomes painfully apparent. To complain of the gas is as bad as a patient quarrelling with the doctor who informs him that he is suffering from a serious disease.

We cannot speak too highly of the introduction of the inverted regenerative burner; for in it we have the best and simplest means of converting the oppressiveness of an ill-ventilated room into the coolness of a conservatory if need be. I have had experience of such a room in my own house. My dining-room was built without any attempt at ventilation; and so a few years ago I inserted into the centre of the chimney-breast one of Boyle's mica flap ventilators, which was connected with the chimney. The result is that, whereas previously I noticed a difference of from 15° to 20° in the temperature between the level of the ceiling and 4 feet from the floor, it has now been reduced to 10° or 12°. At this time we had two of Sugg's "Christiana" burners in use on brackets over the mantelpiece. Last year, however, I fixed a ventilating regenerative burner in the centre of the ceiling, communicating, through a perforated ceiling rose, with a box and 4-inch square iron tube, which was carried into the chimney. The result is that the thermometers, fixed in the same relative positions, only indicate now a difference of 2° or 3°. So much for the exit of the heated gases; but provision quite as important must be made for ingress of fresh air. This I provided by means of a 6-inch channel laid under the floor in connection with the outer air. There is an opening close to the skirting in the room regulated by an adjustable plate, and another inside the fender 6 inches square, which is covered by a perforated plate and a sliding regulator underneath. This plate takes the place of one of the hearth tiles. In this way I obtain a regular supply of air for the room, and what is quite as important to prevent draught, a good supply of air direct to the fire which has not to travel across the room, after having obtained ingress from under doors and windows, chilling the feet and ankles of the occupants. It is therefore our duty to demonstrate to the public that gas, instead of being an opponent and a hindrance to ventilation, is really its best friend and helper.

Seeing that we have so many prejudices to overcome, and many objections, though of a frivolous nature, to dissipate, is it not important that their number should not be increased by a high

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charge for gas? Have not nearly all of us found that the reduction in the charge per 1000 cubic feet, though perhaps made with a certain amount of fear and trembling for the next dividend, has in most cases within six or twelve months, resulted in an increased consumption, which has been sufficient to compensate for the expected reduction in the revenue. We do not need any authority to tell us that it is a mistaken policy to maintain a comparatively high price for an article; for we all know that in 99 cases out of 100 a timely reduction means an increase in the revenue. I believe a plan of discounts given to consumers in proportion to the amount of their consumption is much appreciated, and also a general discount for prompt payment—say, within a month. I have no doubt that most of you can call to mind instances where both of these policies have shown very good results.

In spite of the great reduction in the price of gas, and the consequent increase in consumption in the last ten or fifteen years, there still remains a fairly distinct line below which the use of gas has not to any appreciable extent been adopted; and this line may be drawn at the artizan class. We have not far to search for the cause of this. We have no reason to suppose that it is through any hereditary love for the tallow dip or the paraffin lamp. Is it not plainly evident that the cause lies in the fact that our average working man cannot purchase his gas as conveniently as he can his present means of illumination? If the British workman could purchase his weekly supply of gas as easily as his equal supply of paraffin, I doubt not that this pungent liquid would be a drug in the market. Provided that he can obtain his gas without any serious initial outlay, and procure a continuous supply in quantities within his means, there is little doubt that the artizan would universally adopt it. Methods have been suggested, and in some cases adopted, in order to secure this means of increasing revenue; but I fear that any such proposals as weekly or monthly payments, though realizing their object, would add considerably to the cost of collection.

Recognizing these difficulties, I have designed a prepayment meter, which, Sir, I hope I may be allowed to describe. This instrument, whilst allowing an easy payment, obviates the necessity of collections more often than circumstances conveniently permit. The meter (a sample of which is before you) is constructed to receive a coin, and to deliver, as may be required, its equivalent value in gas. It is of simple construction; the principle being to deal with the gas before it enters the bellows or drum of the meter, and to allow a certain amount of gas to pass, equal in value to the coin inserted; and then, by means of a valve, cutting off any

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further supply until another similar coin be introduced. The supply is not suddenly stopped; but warning is given for about an hour before the supply ceases, by the lowering of the lights, which instantly resume their usual proportion upon the insertion of another coin. The coin is inserted in the drawer in front, which is then pushed home, opening the valve, and admitting the gas. The small dial indicates the passage of gas to the value of one coin; so that by its inspection the consumer may know exactly the proportion of the coin expended and that to come. These meters can be made to receive a coin of any value; but I find that those to receive sixpence or a shilling are the most suitable for small consumers, whilst one for half-a-crown would be better for larger consumers. No alteration is made in the shape of the meter; and there is but little addition to its height.

There appears to me to be great advantages in the use of a meter of this description; for thereby more than one obstacle to the use of gas is removed, with consequent benefit to gas companies. In the first place, it brings gas within the reach of any person who can afford to rent a room, and to use an artificial light. And what an enormous increase to a gas company this means, perhaps though too sudden to be appreciated by all. In the second place it secures the company from bad debts; being on the cash-before-delivery principle—thereby returning a greater revenue from the sale of a given amount of gas; and consequently obviating the necessity for the demand of a deposit, which alone means the removal of a great source of annoyance and anxiety to gas companies. Besides these uses, it is well adapted to that of consumers who wish to keep a check upon extravagant consumption by servants and others—in fact, more than one consumer has expressed his wish to have one fixed. Said one: "I cannot understand your present meters with their mysterious pointers and their hundreds and thousands; but I do know what has happened when a shilling is taken out of my pocket. Now I have to wait till the end of the quarter before I know of any extravagance; but with this meter I can keep a check twenty times in the pound."

Discussion.

The PRESIDENT said he was sure the members were all pleased with the interesting paper they had just heard. They had in the first paper economy in the construction of gasholders; and now they had had shown to them the benefit which would come to gas companies if they extended their business into small cottages. Much might be said on the various points raised in the paper. At the commencement of his year of office, he referred to the matter

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of deposits; and he must again say that in the case of country companies, they were a source of much mischief and obstruction to any increase in the consumption of gas. The inhabitants in small towns had a very strong feeling against deposits. In one place he had heard of, where they were demanded of some publicans, they immediately resorted to oil-lamps. The deposit system was, he believed, being abolished in many cases, on account of its deleterious effect upon the consumption of gas. It was necessary that every obstacle which impeded the growth of the consumption of gas should be removed.

Mr. W. H. H. Broadberry (Tottenham) remarked that there was scarcely a point in Mr. Price's paper which at some time or another had not come under the notice of most of them; and he thought it would result in a considerable improvement to their business if they could remove the obstacles referred to. In the first place, the author mentioned the question of deposits. He (Mr. Broadberry) must say he felt very strongly on this question. There was no doubt whatever that there were not half-a-dozen gentlemen present in the room who would not be considerably annoyed if the baker were to ask them for a deposit before he would deliver bread to them. Why gas companies should be different from other people in business, in the matter of demanding a deposit, he could not at all understand. A few years ago, he must admit, they were a little more independent on the subject of the supply of light than they were at the present time. They could then say to intending customers, "You must come to our terms, or we will not supply you with gas." But this was altered; and they had now to show more consideration to the consumers' terms. The general demand for deposits could not be justified under any system of business whatever. For some years he had to work against his conscience, and ask for a deposit from every consumer. Nine months ago, his Company were not supplying gas in their district to more than about 25 per cent. of the inhabitants; and he certainly believed the principal cause was the infliction of the deposit.

Mr. Livesey: In every case?

Mr. Broadberry replied in the affirmative. Their instructions were not to put on a supply of gas without a deposit; and only consumers who were in existence before this rule was laid down were exempt. He made several reports on the subject; and the system had now been abolished. What they did now was to ask the name of the company that last supplied the intending customer; or if they could show by their receipts that their gas accounts had been promptly paid and so on, then they were supplied. If not, the

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company wrote for a reference; and if they did not get a satisfactory one, they found the simplest plan was to ask for a deposit. He had one case not long ago, in which he wrote to the company who had previously supplied the person applying for gas; and the answer came back: "Kindly give us his address; he owes us for two quarters." (Laughter.) As to the question of oil, there was no possibility of doubt that gas companies had to consider this more than the electric light. He carried out some extensive experiments on this matter of oil lighting; and there was no doubt that, light for light, gas at 3s. per 1000 cubic feet could not compete with oil. When, however, the trouble, the cost of chimneys, &c., was taken into account, most people would gladly pay the small additional cost of gas. He advocated that gas accounts should be collected at shorter intervals than three months. Whether prepayment was to be the system of the future, or whether the collections were to be easier, he did not know; but he certainly thought they should make the collection at least monthly, or even at shorter periods than that. In regard to the question of fittings, the first cost was considerable for small householders. They could buy a good oil-lamp for 15s.; but if they wanted a supply of gas they must spend about £3 or £4 for fittings in order to get the same amount of light. They would have to endeavour to meet the small householders in this extraordinary expense; and then they would certainly be able to hold their own. He thought that the fittings should be put in by the gas companies, and a monthly rental charged for them. The prepayment meter Mr. Price had exhibited was a very ingenious contrivance, and would help to meet the difficulty of quarterly collections.

Mr. GEORGE LANE (Aylesbury) contended that deposits were, in certain cases, absolutely necessary. At Aylesbury, they found it essential to require them from the publicans, and allow teetotalers to go "scot free." They found, on looking back for some years, that the bad debts were mostly caused by the coming and going of the publicans, which showed, perhaps, that they had not a large and lucrative business in the town. In reference to the meter exhibited, it appeared to him to be like a money-box; and when a tenant happened to be in arrear and in serious difficulty, he (Mr. Lane) thought there would be the temptation to disconnect the meter and run off with the source of profit.

Mr. C. E. BOTLEY (Hastings) said it seemed to him that in discussions of this kind very great difficulty occurred on account of there being different kinds of procedure in regard to deposits and so forth in various towns. There were not two cases that seemed to be the same in every respect. By recent Gas Acts deposits were

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sanctioned, provided 5 per cent. interest was paid on them; and he could not conceive that there was any injustice in this. In his own case they asked for a reference from the company who previously supplied the person wishing to have gas; and if they had a satisfactory reply, they connected the meter. In other cases they demanded a deposit, and allowed 5 per cent. upon it. One of their customers a short time ago inquired if they wanted any more money, because he could let them have some at the same rate of interest. With regard to laying on the gas, they were very liberal to their customers, as they put in 100 feet of service-pipe free of charge; and if it extended farther than this, they let them have it at cost price. They did not charge anything for fixing the meter. They charged meter-rents, though he should like to do away with them; but his Directors thought the amount of revenue produced under this head would not justify their abolition.

Mr. LIVESEY: If you abolished meter-rents, you would have to put up the price of gas.

Mr. BOTLEY: Just so; and the consumers appreciated a reduction in price more than the abolition of meter-rental. As to complaints, all gas companies received them. The consumers used in a great many cases bad gas-fittings and bad burners; but they would not be convinced that these were the real cause of their complaints, and said that the gas was bad. The Hastings Town Council had recently appointed a Gas Examiner. They had had extremely good reports from him; and now he believed the Council thought they had made a mistake. They had appointed an Examiner to test the gas; and he was giving the Company a good advertisement, by showing that they more than carried out all their legal requirements. As to the prepayment meter, there was no doubt that they would, if they wished to cultivate the small class of consumers, have to look to something of this kind to help them. The question of fixing fittings in small houses was, he thought, the more serious question for gas companies to consider.

Mr. C. GANDON, referring to the deposit question, said that if it was necessary to ask for a deposit at all, great discretion should be used. If they knew they had an untrustworthy person to deal with, of course a deposit would have to be demanded. He had found the same thing as had been mentioned by a previous speaker with regard to the losses by publicans. They were very difficult people to deal with. They went into a public house, and would leave before the gas officials were aware that anything was wrong with them; and then it would be found that the brewer had a lien on everything in the place. As to meter-rents, this was also a question on which it was rather difficult to lay down any absolute

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rule. The Crystal Palace District Gas Company made a charge of 9d. per quarter for meter hire; the object being not so much to obtain a profit, as to prevent people keeping meters in their houses when they did not use gas. If no charge was ever made, some people would allow the meter to remain *in situ* when they were not using gas, rather than have it removed. As to Mr. Price's prepayment meter, he had not yet had an opportunity of examining it; but he was rather disposed to think that the contrivance would be found difficult to work in practice. Could the meter discriminate between a half-crown and a piece of lead of the same weight as a half-crown?

Mr. JABEZ CHURCH (London) said that, with regard to gas-fittings, he thought it was a question that all gas managers would have to consider—how they could put proper and good fittings in houses. It was certainly one of the problems which gas managers had to solve. In the case of water companies, they had their own plumbers; and they had to use stipulated fittings.

Mr. C. C. CARPENTER (London) said he was afraid there was a tendency to run after the small consumers, and let the large ones go after the electric light. Electric lighting was no doubt making headway; and he thought that the subject should be dealt with. For himself, he believed that everything could be done with gas that the electric light was capable of effecting. He was one of few gas people who lived within the range of electric lighting. They were on one of the oldest circuits in London; and they were continually having breakdowns. With the electric light, unless they had some artificial means of ventilation, the atmosphere was not so fresh as with gas light. They heard people say that ferns and flowers were unable to live in rooms lighted by means of gas; but his ferns "turned up their toes" in a week in a room where the electric light was used. By putting in one of Sugg's ventilating burners, however, the difficulty was overcome. The other occupants of the house where he resided were quite ignorant as to what gas could do; their notion of it being based upon that relic of barbaric gas times—the union-jet burner —whereas gas lighting could be made as artistic and decorative as electricity itself, at less than one-third its cost. He thought the proper education of the consumer was a very important subject, and one that would have eventually to be taken up. He noticed nearly every night, when going home, that some shop or hotel or lodging-house had the electric light where it was not on the night before.

Mr. CUTLER urged the desirability of giving more attention to the small consumers than was done at present. In conjunction

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with Mr. Cloudesley, he had devised a meter to enable gas to be paid for beforehand; and he might say, it would be shortly brought before gas companies and corporations for their consideration.

The PRESIDENT considered the subject they had been discussing was a very interesting one. He thought that if the prepayment meter came into use, some arrangement should be made with the landlords of small houses to put in gas-fittings. In regard to the use of oil, he had read in the papers that the authorities in one part of China considered that more material damage had been done by the oil than by the opium traffic. He believed in Mr. Botley's plan of supplying the services and fixing meters free of charge.

Mr. PRICE, in reply, said that in reference to the question of fraud in connection with his prepayment meter, the arguments that applied to a machine for supplying sweets and so on would not apply to his instrument, because in the case of the meter there was a responsible owner; while with a machine at a railway station a person could drop in a piece of lead and be 100 miles away before the collector came round to take away the pence. As to the question of running away with the meter, he did not think anyone would do this for the sake of the few shillings contained in it; besides, a meter was not a thing that a person could remove without being seen. With this machine, he should think the collection ought to be made once in six weeks. As stated by one gentleman, there was no doubt that the use of the electric light was increasing in the houses of the wealthy, and those to whom expense was no object when a new and attractive light was the temptation; but let things settle down to the inevitable balance of supply and demand, and the usual comparisons of expense—when the quarter's electric light bill was compared with the corresponding quarter's gas account—and he had no fear but that the "survival of the fittest" would obtain. He was strongly of opinion that the small consumers should be looked after; and he believed that a considerable amount of revenue could be obtained from them. He was much obliged for the attention that had been given to his paper.

VOTES OF THANKS.

The PRESIDENT said that before the meeting separated, he thought they should pass a cordial vote of thanks to Mr. Livesey and Mr. Price for the interesting papers they had contributed. They ought to include in the vote Mr. Gadd, for bringing to the meeting models of his arrangement for guiding gasholders, and also Mr. Cripps and Mr. Cutler, who had taken part in the discussion.

The proposal was heartily acquiesced in.

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Mr. BROADBERRY proposed a vote of thanks to the retiring President for the way in which he had conducted the affairs of the Association during his year of office.

The motion was agreed to amid great applause.

The PRESIDENT briefly acknowledged the vote.

This concluded the business of the meeting, and the members afterwards took tea together.

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MANCHESTER INSTITUTION.

QUARTERLY MEETING, DEC. 1.

This Meeting was held at the Victoria Hotel, Manchester. The PRESIDENT (Mr. Thos. Duxbury, of Darwen) occupied the chair.

The HONORARY SECRETARY (Mr. Harrison Veevers, of Dukinfield) read the minutes of the last meeting, and they were unanimously confirmed.

NEW MEMBER.

Mr. J. C. Ingham, Manager of the Ramsbottom Gas-Works, was elected a member of the Association.

ELECTION OF PRESIDENT.

The next business was to elect the President for the year 1889-90; the election, according to rule, preceding by three months the actual time of entering on the duties of the office.

The PRESIDENT remarked that the gentleman who was to succeed him in the chair was one who would fill it with credit to himself and honour to the Institution.

Mr. WOODWARD said he had a very pleasant duty to perform in proposing the election of Mr. T. Banbury Ball, of Rochdale, as President for the ensuing year. He did not know any member of the Institution who would fill the position with more credit to himself and to the Institution than Mr. Ball. His bearing and general manner towards the members of the Institution had been such as to make him many friends. His election would be a popular one; and he did not doubt that his occupation of the chair would give satisfaction to the members generally.

Mr. W. W. HUTCHINSON (Barnsley), in seconding the proposal, said that Mr. Ball's professional ability entitled him to the highest honour which the Institution could confer, while his integrity and gentlemanly bearing were qualities calculated to bring credit on the Institution.

The PRESIDENT observed that he wished to echo every word which the mover and seconder of the resolution had said in regard to Mr. Ball. That gentleman had had considerable experience in the management of Gas Institutions. He had been on the Council

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of The Gas Institute, and seen how things were there conducted (though whether he had seen anything there to emulate might be a matter of opinion); still, he was a gentleman who would, as President, be calculated to enhance the interests of the Institution, if he retained his health. They were sorry that his health had not been all that they or he could have wished; but they were glad to have him amongst them, and they would do credit to themselves in electing him President of the Institution.

The resolution was carried by acclamation.

Mr. BALL remarked that no one was more fully aware than he himself of the few merits which he had to recommend him to their selection as President of the Institution. During the past year, occupying as he had the post of senior Vice-President, he was sorry to say that his attendances had been very few and far between. This, however, had not been his fault. It was partly owing to the fact that the works he had to superintend required a great amount of personal supervision. This was an experience known to many of them; for the technical assistance afforded them was, in many instances, of the most meagre description, and absence from home could not therefore be undertaken without serious thought and consideration. This was one of the reasons which had prevented him attending as often as he could have wished during the past year. By their kindly forbearance, these absences had been overlooked; and if his health was spared, he hoped, during his year of office in the chair, to pay better attention to the business of the Institution, and to attend oftener, so that at the end of the year he might deserve their confidence as he at present possessed it.

THE SECRETARYSHIP.

The HONORARY SECRETARY proposed an alteration in Rules 2 and 3, by the substitution of the words "two Honorary Secretaries" for "Honorary Secretary" in the places where these words occur. He said he suggested this alteration at the last meeting of the Committee, after filling the office of Secretary for nine months, and with an intimate acquaintance with the Institution from the commencement. The suggestion was not a new one with him; for he had advocated the appointment of a senior and junior Secretary for many years. The work at the meetings was—as Mr. Hutchinson, the late Secretary, would bear him out—really too much for one man. The issuing of circulars was a serious matter, for 120 of them had to go out four times a year; and this, with the engagement of rooms, and looking generally after the arrangements for the meetings, was too much for one gentleman to do with any degree of comfort. Then when the Secretary retired,

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a new man came who knew nothing about the work. If the resolution he proposed was carried, there would be two Secretaries. The senior Secretary would look generally after the conduct of business, and the other undertake the drudgery and detail work, and qualify himself for the senior position when it became vacant. He did not advocate this from any selfish motive, because his term of office was drawing to a close. He thought, however, that if The Gas Institute had done much the same thing, and had an Honorary Secretary as well as a paid Secretary—though he did not advocate anything in the nature of payment here—it would have been very much better for the parent association. He had brought forward this proposal merely to see whether or not the members approved of it.

There was no seconder to the motion; and the President announced that, as this was the case, the proposal fell to the ground.

OIL AND OTHER ILLUMINANTS, AND THEIR EFFECT ON THE CONSUMPTION OF GAS.

The members then proceeded to discuss Mr. J. Dalgliesh's paper bearing the above title, which was read at the Manchester meeting in December, 1887, and also the supplementary paper presented at the meeting held at Doncaster on Aug. 25, 1888 (*ante*, p. 225.)

The PRESIDENT said he had to apologize on behalf of the Committee for the delay which had occurred in taking the discussion on this paper. It was read at their meeting on Dec. 3, 1887; and twelve months was a long time for a discussion to be deferred. He had experienced the same difficulty in connection with the last paper he read. The result of such delay was that the subject got out of one's mind; and they had to read up for one meeting after another, or else they forgot what had taken place in reference to the particular matter to be debated. This militated against discussion, which was to be deplored, because an Institution like theirs was more valuable for the discussions which took place than for the reading of papers. However, there had been many difficulties in the way; and the discussion had been postponed from time to time. But he hoped that now it was to take place, there would be as good a discussion as the subject warranted, and as was consistent with the delay that had occurred.

Mr. DALGLIESH expressed regret at the delay. There had, he said, been other business which had necessitated the postponement of the discussion; and he was unable to attend the last meeting, held at Doncaster, so that the matter had to be again deferred. In compiling the paper, he experienced considerable difficulty in

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not being able to get from the various engineers and managers to whom he applied exact answers to his question as to the local consumption of oil. Very few were able to state, even if they applied to the railway companies, the quantity of oil imported into their town, nor could they give the actual number of consumers of oil, without a house-to-house canvass, which would have been very difficult, and required much time. He could not expect that managers of gas-works would go to the trouble and expense of obtaining such information; and even if they did, the time at his disposal before he had to read the paper was so limited that it would not have sufficed for such an inquiry. He therefore took this course: Taking the population of the towns as shown in the table, he allowed the Government standard of five persons to each house; and thus arrived approximately at the number of dwellings. Of course, from the returns published each year, he was able to get the exact number of consumers of gas; and deducting this actual number from the assumed number of dwellings, he arrived at the number of residents not using gas, and these, he presumed, were users of oil or other illuminants.

The Honorary Secretary (Mr. Harrison Veevers, of Dukinfield) said he had received a letter from Mr. T. Newbigging, who was then on his way to South Africa, in which he said that he had intended contributing something to the discussion on Mr. Dalgliesh's paper, and had jotted down a few things that had occurred to him. The enclosure was as follows:—"I had not the opportunity of listening to Mr. Dalgliesh's paper; but I have recently perused it, and was entertained with the choice passages from the ancient and modern history of artificial lighting communicated to us by the author. Indeed, I consider that some such title as that would have been more appropriate for the paper than the one which Mr. Dalgliesh adopted; for he does not give us many suggestions as to how illuminating gas may best meet the competition of oil and electricity. Probably he thought that the discussion would supply the deficiency. As a slight contribution to this end, I venture to express the opinion that gas lighting has no competitor to fear, so long as those who have the control and management of gas undertakings aim at the cultivation of what I would call the three graces—Cheapness, Lighting Power, and Purity; and the greatest of these is Purity. Whatever other hindrances stand in the way of the more extensive adoption of gas for lighting and cooking purposes, should be removed. Chief amongst these, I class the deposit system. The adoption of this system at the outset might almost have been a suggestion of the enemy. At any rate, save in very exceptional

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cases, it ought to be discarded. There is nothing, in my opinion, that more handicaps the extension of the use of gas, and assists the competition by oil, especially amongst the smaller consumers in towns. But, all round, the practice of enforcing the payment of deposits is a most objectionable one. I candidly confess that if I had it to pay in my own case, I should look upon it as a reflection on my honesty or my credit, or both, and would refuse to comply with the requisition. Under a prompt and efficient system of collection, there is no need for the deposit system."

Mr. W. Woodward (Bury) said there could be no doubt that they did owe an apology to Mr. Dalgliesh for the neglect with which they had treated his paper; but in some respects Mr. Dalgliesh was himself to blame, for he had submitted two or three sets of statistics, and the Committee might be excused for diffidence in bringing the matter forward under the circumstances. There was no doubt in his mind that the great obstacle to the increased consumption of gas was its price. They found in Bury that, by reducing the price to slightly under 2s. per 1000 cubic feet, they had recovered consumers who gave up the use of gas six or seven years ago. Although they had lost one or two large consumers, their consumption had increased 2 million cubic feet a month since they reduced the price of gas. This went to prove that the price had much to do with consumption; and he was assured by pawnbrokers in the town that, if they were willing to take them, they could have their shops simply flooded with oil-lamps. Oil was at a discount in Bury at present. He considered the meter-hire system an injustice altogether. It was absurd to charge customers for the instruments by which they measured the gas. They had neither deposit system nor meter-hire at Bury; and this year they had an increase of more than 10 per cent. in the consumption, whereas in other years they had had a decrease.

Mr. T. B. Ball (Rochdale) observed that, although he agreed with Mr. Woodward that the reduction in the price of gas to a minimum was the best means of competing with oil and illuminants of that description, he did not agree with him altogether that this would to any appreciable extent bring back consumers who were lost to the gas company or the corporation. Nor was he altogether sure that, if it would, it would be an unmixed gain. A great deal had been heard lately about small consumers. In Rochdale they had a considerable number of small consumers. The population was perhaps 70,000; and they had nearly 20,000 meters in use. Of these 83 per cent. were two-light meters, which was tolerably conclusive evidence that they had a great many small consumers; indeed, it was an exceptional thing for property to be

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erected in the town without the gas supply being put in. The fittings were put in, and the meters supplied by the landlord; they had not a single meter belonging to the Corporation. This, as he had said once before, was a great evil; but it removed at any rate the difficulty sometimes put forward, of the expense incurred by small consumers in procuring these things. And yet, with this advantage, and with no expense whatever to be incurred—they could have the gas turned on at will—the people still preferred oil; and the quantity of gas they would burn under any circumstances was exceedingly small. In many cases it did not exceed 2000 cubic feet per annum; and the cost of inspection and collection on that amount would certainly not be less than 1s. per 1000 feet. The inspector went eight times a year; the collector probably had to go another eight; and there was all the expense of book-keeping for the 2000 feet, exactly as there was for a consumption of 200,000 cubic feet. Altogether, he was not at all sure that the small consumer was such an acquisition as some appeared to suppose. The prompt collection of accounts was stated to be one method of counteracting the difficulty these people experienced in getting together 3s. or 4s. at the end of the quarter; but if they were to spend another shilling per 1000 cubic feet in collecting these small sums, it became a losing, instead of a profitable business. He quite agreed with the recently-expressed opinion of Mr. Hunt, that they must look at these things after all from a commercial point of view. It was no use attempting to sell gas in quantities of 2000 cubic feet per annum if the transactions ended in loss. They would not be any better off for any amount of that business; and this, after all, appeared to be the rational view to take of it. Everything, he thought, had been done at Rochdale, except the collection of accounts at short intervals, to encourage consumption. Whether even the plan of frequent collection would bring these people back to burning gas, he must take leave to doubt; and he also doubted whether they would be very great gainers by the transaction even if it did.

Mr. W. W. Hutchinson (Barnsley) observed that the competition of oil and other illuminants had to be met in the course of their business; and it was necessary to know the best means of dealing with it. He believed that if means could be taken to induce all property-owners to put in gas-fittings, one reason for the non-consumption of gas would disappear. As it was, the few shillings which it cost to put fittings in a cottage house formed an insuperable bar with many people to the use of gas. Though these small consumers might be rather troublesome and expensive

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in the matter of the collection of accounts, and might not be a source of much profit, they were nevertheless a stable source of consumption, and were not liable to much change. It, therefore, seemed to him desirable to stimulate this branch of the business. Oil-lamps could be obtained at an almost infinitesimal price—for about 1s. each; and then the consumers of oil had the advantage of the weekly payment system. The cart went round with the oil; and the weekly payments were so low that the sellers of gas could not very well adopt the system, and collect such small amounts. He was afraid the attempt to meet the competition of oil in these cases by weekly collections would not pay. The adoption of prepayment meters might afford a means of overcoming the difficulty; but whether there was a prepayment meter in the market sufficiently reliable for the purpose, he was not just then prepared to say.

Mr. J. Braddock (Radcliffe) remarked that his experience was that the small consumer might be depended upon to take about 4000 cubic feet of gas per annum, which was double the quantity named by Mr. Ball.

Mr. A. Shires (Biddulph) said it did not invariably happen that an increase in consumption followed a reduction in the price charged for gas. He had only obtained five new customers as the result of a recent reduction; and he did not know that all these would pay him. As to fortnightly or weekly collections, he could not say that he was much enamoured with the idea. A certain class of cottage occupiers would not pay; and if they were to go for the money fortnightly, they would appear to be praying and begging for it in a way which would not be pleasant.

The President said that in Darwen they had reduced the price of gas, in addition to taking away some restrictions; and since he mentioned this matter in his Inaugural Address in February, 700 or 800 cottage meters had been connected—the result being that the consumption of gas was 15 or 20 per cent. more than last year. They expected, of course, that there would be some increase of the loss through bad debts; but still they obtained a stated consumption, which was going on continuously. As they had enlarged their works, they could produce the extra gas required; and the standing expenses were just the same whether they had this additional consumption or not.

Mr. Ball inquired whether the President could say what proportion of the increase was due to the old, and what to new consumers?

The President was afraid he could not answer that question correctly; but taking the increase at 15 per cent., he should say that

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certainly from 5 to 7½ per cent. of the increase came from houses where they formerly had gas, but at which they were not consuming it previous to the reduction in price. The rest of the increase was from new houses and new mills; but he estimated that, at any rate, from one-third to one-half of it was from old property. He was in the same difficulty as Mr. Ball with respect to the meters, which in most cases belonged to the consumers, or the owners of the property. It seemed to him a remarkable state of affairs. None of them, if in business as grocers or drapers, would ask the customer to bring his own scales or his own yard-stick; but in this matter of the sale of gas, gas companies had, practically speaking, done this. In his opinion, the practice was totally indefensible; and it certainly had been one of the drawbacks to obtaining consumers. So far as the internal fittings were concerned, the houses in Darwen were like those at Barnsley, referred to by Mr. Hutchinson. No one thought of building houses without putting gas-fittings in; and he did not want anyone to get into the habit of doing so, because, the fittings being in, they certainly had gone a long way towards getting a consumer of gas when a tenant came into the house. Mr. Ball had told them that, with a population of 70,000, he had 20,000 meters. That certainly appeared to be a very great proportion; and they had nothing like it in Darwen. It would seem, as Mr. Ball said, as if they had a meter in almost every house in Rochdale, and perhaps more than one on some premises. The information which Mr. Dalgliesh had collected would be valuable for reference. He could not say that the whole of it was strictly correct, because, as Mr. Dalgliesh explained, he had had to take for granted certain bases for calculation. In Darwen a calculation based on the population did not work out correctly. The preparation of the table must have involved a great deal of trouble; and he hoped it would be found useful.

Mr. C. W. Hastings (London) asked whether the President meant to say that the houses in Darwen were provided with chandeliers and brackets, or only lined with pipes.

The President replied that a place was left for the meter, and pipes were laid to the centres of the ceilings, or to the walls in every room of the houses, except perhaps the attics; and brackets and one or two light pendants were fixed.

Mr. Hastings said this was a thing they did not experience in the South at all.

The President remarked that it was very general in Darwen; the gas-fittings being included in the architect's specifications for ew houses.

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Mr. N. MEIKLEJOHN (Longwood) said that the sum of 1s. per 1000 cubic feet which Mr. Ball mentioned as the cost of inspection seemed to him an absurd amount. In his (Mr. Meiklejohn's) case, it would come on this basis to more than £1500, as about 80 per cent. of the meters in his district were two-light meters; and the £1500 would be more than the total of his gross profit.

Mr. BALL explained that he did not mean to say that the cost of inspection alone would be 1s. per 1000 cubic feet. He meant that the cost of inspection, collection, book-keeping, expenses of the accountant's department, and bad debts would come to 1s. per 1000 feet for these small tenement occupiers.

Mr. DALGLIESH confessed that the discussion had not been so extensive as he thought it would have been; and as no doubt it would have been if it had been taken earlier. He could quite understand that the subject had gone out of the minds of members, as a good part of it had escaped from his own. He was sorry Mr. Newbigging was not present to give expression to what he had been pleased to write. The only fault he seemed to find was that he (Mr. Dalgliesh) might have called the subject of his paper "Artificial Light," instead of "Oil and other Illuminants." If the members read the paper carefully, they would find that he dealt pretty largely with the production of oil, both in regard to its manufacture from shale in Scotland, and about it being obtained from the natural wells of America and Russia. He also showed the commercial and financial position of the oil industry last year. So, with all deference to Mr. Newbigging, he thought there was ample justification for the title. He also referred in the paper to electricity. Some of them—himself amongst the number—had to compete with it; and the result had been to prove that it was not so much electricity they had to fear as the consumption of oil, which was retailed in small quantities. As to Mr. Woodward, if he had known the facts, he would not have committed himself to the statement that he (Mr. Dalgliesh) had issued two or three sets of statistics. He had never altered a single figure. He had explained once before that, in the table, the consumption per mile of main was substituted for the capital. He wished to correct this, but was not allowed to do so; and this being the case, he had to go to the expense of having slips printed showing the figures in their correct form. Under these circumstances, he ought not to be charged with having altered a single statistic; and possibly if Mr. Woodward had known the facts, he would have been a little more charitable. He thanked Mr. Ball for his temperate remarks, all of which he agreed with, except in the statement that cottage consumers only took 2000 cubic feet

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per house. He (Mr. Dalgliesh) had the misfortune to be in a wide district where the consumption was very small; but he found that the cottage consumers burned more gas than Mr. Ball mentioned. He also considered the statement as to the 1s. per 1000 cubic feet was over-estimated. The great evil in many towns, where they were supposed to be supplying dear gas, was the extent of the district, and the unprofitable length of the mains. His own was a case in point. They had 66 miles of mains, with a consumption of 773,843 cubic feet per mile. The average of the United Kingdom (as worked out from the official returns) was 4,114,000 feet per mile of main; but if in places like Glossop they could only get it to two or three million feet per mile, undoubtedly the companies and corporations would be glad to bring down the price materially. He agreed with what certain speakers had said in regard to gas-fittings. The fault was not in some cases so much dear gas as bad fittings. It was a great mystery to him how some of the fittings in Glossop could be termed "fittings" at all. In nine cases out of ten, in the old fittings of houses, there was nothing but ¾-inch piping hung like ropes, without the slightest attempt to make a gradual fall to the meter. With the slighest disturbance, these fittings got out of order; and the people refused to do anything towards repairing them. There were at least a hundred houses in the town in that condition to-day. He hoped the statistics he had prepared would be useful. The best guide would be found to be the consumption per mile of main. Whatever differences there might be in the consumers or the population, the consumption of gas per mile of main was a true indication of the position of a company or corporation.

The PRESIDENT remarked that the duty of passing a vote of thanks to Mr. Dalgliesh was discharged at a previous meeting.

GASHOLDERS WITHOUT UPPER GUIDE-FRAMING.

The consideration of the paper read by Mr. T. Newbigging, at the previous meeting, on the above subject, was next proceeded with. (See *ante*, p. 243.)

The PRESIDENT said they had now to discuss the paper read at the last meeting by Mr. Newbigging, on the subject of "Gasholders without Upper Guide-Framing." He was sorry Mr. Newbigging happened to be away; but he should ask Mr. W. Gadd to introduce the discussion by some additional observations.

Mr. W. GADD (Manchester) said he was obliged to the President for calling upon him to introduce the subject. The model which he had brought was not the one seen at Doncaster. It was a

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larger one with three lifts, and would, he thought, be found a little more interesting than the old one. Since he last had the pleasure of addressing them at Doncaster, he had been engaged upon a great number of experiments with regard to the principle involved in the construction of a gasholder on this system. As they were well aware, there had been considerable discussion on the subject since the paper was read; and it was highly probable that there would be much more discussion until the invention was properly demonstrated. It was his desire to bring the demonstration to the issue; and he had good reason for believing that it would not be long before they would have the pleasure of seeing and examining for themselves an actual working holder on this plan. This would set the matter at rest once for all, whether a holder was safe under such conditions. The experiments he had made, instead of contributing in any way to cast doubt on the stability of a holder on this method of construction, had added, he was going to say, almost infinitely to his faith and belief in the final results and success of a holder constructed in this manner. In his paper, Mr. Newbigging said that, as at present constructed and guided, gasholders were capable of resisting the maximum crushing strain that was exerted by the greatest wind pressure upon their exposed side—*i.e.*, a pressure equal to 20 lbs. to the square foot exerted upon a plane represented by 50 per cent. of the area of vertical transverse section of the holder. Well, he thought he would submit the model to an actual strain, to try what it would stand. He took the model they saw at Doncaster, and submitted it to an actual strain—not to any supposed reduced strain—of 20 lbs. to the square foot exerted on a plane represented by 50 per cent. of the area of vertical transverse section of the holder. That pressure of 20 lbs. to the square foot took no effect whatever upon the model. He doubled it, and again it took no effect; and he determined to increase the strain until he ruptured the model, or gave it a permanent set-over. He kept increasing the strain, and both he and Mr. Wilson, who assisted him, were surprised at what took place. They weighted it until they did give it a slight permanent set-over; but it affected it so little that, when the force was removed, the model would work, though imperfectly. The exact force necessary to bring it to the point of injury was a force of 648 lbs. to the square foot. Mr. Newbigging gave 20 lbs. to the square foot as the greatest wind pressure; but it actually required 648 lbs. to the square foot on that little delicate model to give it a permanent set-over in the way of injury—nothing short of that did it. This, he was bound to say, somewhat startled him. He had not expected it would stand so much; and he found it necessary to

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seek for an explanation of the cause of this resistance. The model, he wished to explain, was simply a cylinder of ordinary thin tin, with a tin top. He was not going to say that this represented exactly the comparative strength of a large holder. The model might be a little stronger, in proportion, than the large holder, because although it had no upright standards whatever round it, still the thickness of the tin might be said to be greater than the sheets would be, in proportion, in the large holder, and this would compensate for the absence of upright supports. He was free to admit that it might be stronger in proportion; but see the difference! There was a difference in the increased proportionate strength of 648 lbs. to 20 lbs.; yet the model was not this much stronger. It was impossible to conceive of its being anything like so much stronger. Suppose they assumed it to be double the strength—that was 40 lbs. to the square foot; but, instead of that, the model required a strain of 648 lbs. to cause it to set-over. There was therefore something in addition to the construction which had to be investigated; and he determined to inquire into it. They had, no doubt, all read the able articles on the subject of gasholder construction in the *Journal of Gas Lighting*. He was pleased to contribute his little meed of admiration of these articles, which were very carefully written, and were upon the acknowledged and admitted lines of mechanical construction. But there was a form of structure which, so far as he knew, had not been very carefully examined. It was true that it was many years since he consulted the text-books, and he was speaking from memory; but he did not recollect that Rankine or any of the other authorities had investigated this point, though he had a hazy notion that a French writer had treated of it. However, it was so difficult that he determined to investigate it *de novo*. If they took a base, which might be represented by the bottom curb of the holder, and fixed thereon (say) four upright beams, joined rigidly at the base, they had a system of cantilevers. The force required to bend one, multiplied by the number would equal the force required to bend the four; but if these cantilevers were joined at the top by another rigid bar, which might be represented by the cup rings of the holder, the actual force exerted transversely would be four times what was required in the first example. The reason of this was that two bends in opposite directions of each upright member took place when they were joined top and bottom; whereas, when they were unconnected at the top, as in the first example, there was only one bend. This accounted for double the force being required. But, as these two bends were in opposite directions, they had to be made about

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a neutral axis lying midway between the two horizontal members. This halved the length of leverage at which the force took place; and this again multiplied the resistance by two, which accounted for four times its strength in resisting strains. If they had the upright from a bottom curb standing up, and they should then be joined by a rigid ring at the top, the resistance to the overturning of these uprights was multiplied by four, by the rigid ring at the top. He thought it necessary to go into this, to give them the reason why a holder which was held rigidly at the base became very strong indeed. It had been suggested that a great deal of strength would require to be put into a holder built on the plan he proposed; but they would see that there was no reason why this should be necessary. Still, he had always admitted that, if it were necessary, it was easily done; and it would form an infinitesimal addition to the expense, when compared with what was swept away in the guide-framing. He wished to draw attention to the fact that the spiral motion was exceedingly slight. The screw or spiral was of what might be called the quickest possible description. The holder was a structure with an enormous base; and this base was held as firmly as though it rested on the ground. If they had such a structure resting on the ground, they could not conceive that any wind would blow it over. By his plan, the holder was in a really stable position. As long as the bottom curb kept in form, there was no possibility of any accident taking place; nor was there any possibility of jamming. It would not matter if they had 2 or 3 inches of play between the rollers; all that was necessary was for it to be on one set of rollers at one time. They had tried the model under all possible conditions.

The PRESIDENT said that, if he understood Mr. Gadd aright, in taking a pressure of 20 lbs. to the square foot, and applying it to one-half of the complete surface of the holder, they had what Mr. Newbigging considered a fairly heavy wind pressure; but that, in the case of the model in question, it stood a pressure of 648 lbs., as against the 20 lbs. It certainly seemed an enormous difference. One could not however help noticing that, in the structure as it was, having the frame of the holder inside, and with a grip on the guide-rails all round, if wind pressure came from one side, that side was held down, while the other side was held up. This was different to a holder with outside framing; inasmuch as in that the bulk of the strain was on the opposite side to that from which the wind came, while in this case it was distributed all round. It was an exceedingly ingenious arrangement. Whether Mr. Gadd was to get the credit for the invention, he did not know. He saw that

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Mr. Livesey had been reading a paper on the same subject, though he arrived at the same end in a different way. Mr. Gadd took a spiral frame all round the tank; while in Mr. Livesey's it went first one way and then another. Anyway, they had Mr. Gadd's paper before Mr. Livesey's, though both were based on the same line of thought.

Mr. HARRISON VEEVERS (Dukinfield) remarked that when Mr. Newbigging mentioned that he intended to read a paper on gasholder construction, he said it would rather surprise the gas world. It certainly astonished him more than he was led to expect. It certainly surprised him that such a total revolution in gasholder construction should be first brought out at a meeting of their Institution. He had not much opportunity at the last meeting of considering the subject; but, on reflection and studying the paper, he came to the same conclusion as the President, that the holder was fixed by the pressure of the rollers all round. Leaving the scientific part of the subject, he should like to say something as to its æsthetic aspect. Gasholders were not things of beauty. Designed and painted in any way they liked, they were not pleasant to look at. A holder constructed on Mr. Gadd's principle was, in his opinion, more a thing of beauty than if it had a number of sticks standing round it, pretending to hold it up. From this point of view alone, he was inclined to look with favour upon it.

Mr. N. MEIKLEJOHN (Longwood) said Mr. Gadd had shown them that a lever bound at both ends was four times as strong as one with one end free; but he did not gather that anything he said gave a reason for the extraordinary strength of his model. All holders were at present made, as the one proposed by Mr. Gadd was, with a top and bottom curb, and a space of intervening sheeting; and he should like to have heard Mr. Gadd explain the difference between the resisting strength of an ordinary holder and his model. The idea seemed to be that the fixing of the bottom curb would add the extra strength; but as it was to be a floating vessel, which would rise up and down, he had never yet been able to see how this rigidity was to be obtained. He did not for a moment deny that it was as Mr. Gadd represented it; but he had not been able to see how the fixing would add anything to the actual strain it would resist in case of wind pressure coming against the side of the holder. With Mr. Veevers, he thought the æsthetic point of view should not be lost sight of; but granting that the engineering feat was possible, they ought to know something of the difference in cost. They were to have a total taking away of the guide-framing; but if the cost came anything near that of guide-framing, he should prefer to have the framing. The framing did add to its

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appearance; and it was certainly useful when the lutes froze and snow gathered on the top. With the holder as it was in the model, it would be a rather difficult thing for a man to go up and clear the ice out of the cups or the snow off the top. There might be a spiral framing for these purposes; but at present the framing answered the purpose, as well as resisting the over-turning pressure of the wind. If the difference in the cost of the two structures was not large, he should certainly prefer to still put up the guide-framing.

Mr. W. W. HUTCHINSON (Barnsley) wished to know how long the actual holder on this plan, to which Mr. Gadd referred, had been erected; and if it had stood the test of any strong winds.

Mr. GADD explained that the holder was not yet erected, but was in contemplation.

Mr. J. DALGLIESH (Glossop) asked if Mr. Gadd could give some idea of the difference in cost of the two arrangements. He had some sympathy with the view expressed by a previous speaker; and if the cost was not very much lower, it would certainly, as far as his experience went, be better to stick to the old form. At the same time he admitted that the new invention gave a perfectly rigid structure. Could they not combine the two things, and have a light framing round a holder on Mr. Gadd's principle? They ought, however, to have some information as to the cost, so that they might be better able to form an opinion. There would certainly be some difficulty in getting to the top of Mr. Gadd's holder without some arrangement like a spiral staircase.

Mr. BALL said he should like to ask just one question. As the framing was to be done away with, the strain it was called upon to bear would have to be taken up somewhere else; and it seemed to him it would be taken by the tank-guides. Would this entail any additional expense in the construction of the tank? Would any additional strain be thrown upon the guides in the tank; and if there was, would it be sufficient to cause any additional expense in the structure?

Mr. J. PARKINSON (Brighouse) assumed that the whole of the weight was taken by the tank-guides to the bottom lift; and when they came to erect a three-lift holder, these would have to be very strong, and bear a great weight. There was free space for the vertical sides of the second lift, and also for the bottom lift. For a single-lift holder, the arrangement might do where the spirals were held to the tank-wall; but when they came to the vertical sides of a second lift, there would, he thought, be a source of weakness there.

The PRESIDENT, referring to Mr. Veevers's remark on the

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æsthetic side of the question, said that economy with safety were the two main points they had to consider. He did not think there would be any difficulty in making arrangements to get to the top of the holder. The question of cost was, however, one that they ought to know something about; and if, as Mr. Gadd said, it would not be long before a holder on his plan was erected on a large scale, it would be interesting to see what it cost. He was sorry that some gentlemen like Mr. Newbigging, who usually took part in the discussion, were absent that day.

Mr. GADD said he felt as strongly as the President the absence of Mr. Newbigging, who would certainly have been of great assistance in the discussion. With reference to the objection of Mr. Meiklejohn, that there was no provision for climbing on the holder to clear the frozen lutes and so on, he had only to say that this was a matter of detail, which would have, of course, to be provided for. In the illustration which accompanied the paper, a hand-rail was figured round the top of the holder, such as was now common enough. A rail could also be put round each lift, and they would make a firm and safe road; and then a little straight iron ladder could be put up at some convenient point at the side of the holder. This was a little matter of engineering detail, which any engineer could design and carry out. As to the cost, if his plan were not cheaper, he did not know why anybody should be at the trouble to depart from the old lines; but Mr. Newbigging, in his estimate, put the cost of the guide-framing, roughly speaking, at 50 per cent. of the cost of the whole structure. He (Mr. Gadd) would not assert positively that this was a correct estimate. But if it were placed at 40 per cent., or any other figure, it was obvious that there must be an enormous saving by taking away the great weight of guide-framing; and it was on this that the commercial success of the invention must be shown. Whether Mr. Newbigging's estimate was under or over the mark, was a matter of considerable interest; but in itself it was quite immaterial. He thought a saving of 50 per cent. was not very far from the mark; for they not only saved in the framework itself, but they saved all the piers and foundation-stone preparation round the tank for building the guide-framing upon, which in cost of material and labour, must form a very important item. As to the tank-guides, which Mr. Ball referred to, there was no doubt that the strain would have to be taken up by the guides in the tank. It must be taken up somewhere; and the final resistance to the strain was in the spiral-guides round the tank. The strength lay in the fact that the spiral-guides were built into the tank, and could not give way, unless they

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were torn bodily away; and it would be very easy to design a method of fixing the guides into the tank, by long Lewis bolts, or something of that kind, so that no reasonable force could pull them out. This could be done without adding materially to the expense, because the guides had to be fixed at present; and there need be no very great addition to the expense. As for the æsthetic question, this, of course, might be interesting; but at the same time it was perfectly true, as the President had said, that it could not be considered in the face of possible economy. But when all this was said, he confessed—though it might be prejudice in favour of his own child—that he saw a simplicity about the structure he had designed which commended itself to him. He compared it to the idea of the structure of the pyramids of Egypt, about which there was a grand simplicity greatly to be admired; and he was inclined to think that when they saw these holders on a large scale without guide-framing, they would admit they had a beauty which was absent from the ordinary structure of sticks and rods. However, this was quite a matter of taste; and for the present, they must adopt the dictum of the President that æsthetic considerations must give way to those of economy. Then he was asked as to the strains, and how the rollers were to grip the guide-rails and keep the holder firm. The explanation was this: In the present holders, if there was any wind pressure, the holder was driven horizontally to the framework on the opposite side to that from which the wind came. In his new holder the bottom curb was gripped and held; and the strain became one of the cantilever type. If they took an imaginary line from the top of the holder downward to the roller on the other side, they had the resistance, so to speak, of a direct strut through the centre. They had no strut, it was true; but they had a circular girder-bond all round. The model stood an extraordinary strain; and he did not think the same model would have done this if with guide-framing.

The PRESIDENT remarked that, as in the case of Mr. Dalgliesh, they accorded to Mr. Newbigging a vote of thanks for his paper at the last meeting. They were, however, very much obliged to Mr. Gadd for being present that day.

The PRESIDENT, in the absence of Mr. T. Newbigging, read the following paper, which had been prepared by that gentleman:—

THE PRESENCE OF WATER OR MOISTURE IN COAL AND ITS EFFECTS.

In my first paper, read before this Institution some time ago,* on the subject of "Water," I dealt with that substance *per se*—its

* See "Reports of Gas Associations" for 1886, p. 268.

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physical character and effects, and its constituent gases and the properties of each. On the present occasion, I propose to speak of water in connection with the manufacture of coal gas. The part which water or moisture plays in the economy of gas manufacture is important and wide-reaching. Its presence is useful and even indispensable under certain circumstances; whilst in others it is highly objectionable. Let us now trace it throughout its various manifestations.

The spontaneous combustion of coal when stored in a dense mass, in a wet or moist condition, is a not unusual occurrence in the experience of gas managers. I do not know whether any of the members present have been unfortunate enough to have added this experience to their other qualifications; but if they have, I am sure they will be ready to admit that it is one of the most undesirable occurrences that has overtaken them during their professional career.

have had one experience of the kind; and the vivid recollection of it remains with me to the present hour. For several days I perceived in the retort-house a disagreeable smell, which produced a kind of sickly and choking or smothering sensation as I drew breath. At first, being inexperienced as to the cause, it did not strike me that anything was wrong, though the phenomenon was unusual and unaccountable. The objectionable smell continuing, and even becoming more pronounced, it suddenly dawned upon me that spontaneous combustion in the coal had taken place. A close examination of the heap of material (to the amount of about 1500 tons) stored in one of the adjacent coal-stores confirmed my suspicions; and without delay I had about a dozen men employed in reducing the thickness of the heap at the place where it appeared to me the fire was smouldering. The labour of getting down to the source of the mischief was one of great difficulty, and even danger. The centre of the mass began to give off suffocating and deadly fumes in considerable volume; and for hours the men toiled at the work—some of them being so far overcome as to be compelled to desist, and seek the open air to recover their breath. The fire had spread like the roots of a tree in every direction from the centre of the heap, and was only extinguished with difficulty, by deluging it with water from a hose-pipe which I called into requisition. Many tons of the coal were charred, and rendered worthless so far as gas making was concerned; and the sulphurous odour hovered about the premises for days after.

There is this liability to spontaneous ignition in almost all bituminous coals of a friable nature. It is due to more than a single cause. It may arise from the condensation of oxygen within

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the pores of the carbonaceous particles, just as oily cotton-waste will fire spontaneously in the same way by the rapid absorption of oxygen. According to Professor Abel and Dr. Percy, water or moisture does not accelerate, but rather retards spontaneous ignition under these circumstances. The danger of firing is greatest with those coals which contain a large proportion of iron pyrites in the shape of nodules, or "brasses" as they are called, and which are stored in a mass in the wet condition. These "brasses" become oxidized by the atmospheric oxygen dissolved in the water with which the coal is saturated; and the heat thus generated raises the coal to ignition point. The moral, of course, is to avoid using coal of this character, which is costly in other respects; and if it must be used, then care should be taken to hand-pick the pyrites as far as possible, and to store the coal in a dry state, or otherwise to adopt means of thoroughly ventilating the mass with a swift current of air. Unless the ventilation is thorough, the admission of air will do more harm than good, as a sluggish current will not reduce the temperature, but rather tend to develop and increase it.

When coal is exposed to the weather, being stored in the open air without any protecting covering, it is not only liable to be wetted by rain on its outer surface, but it also absorbs and retains moisture within its structural interstices. Bituminous or gas-producing coal, from its comparatively soft or friable texture, is especially affected in this latter particular. Cannel, by reason of its close-grained and harder character, does not absorb water or moisture in the same degree. The effect of this excess of moisture in bituminous coal is to produce disintegration, reducing the size of the lumps, and converting them to a considerable extent into dust and culm. The exposure of the coal in the winter season in this climate is, of course, the most objectionable as regards disintegration. In hot climates the intense heat of the sun produces disintegration. The ill-effects of this absorption of moisture do not end there. Oxidation of the particles of the coal also ensues; and as this is only another name for eremacausis or slow-burning, the material is not only reduced in weight, but its gas-producing power, both as regards quantity and quality, and its coking qualities, are greatly impaired. This is the common experience of gas managers; and the desirability, and even the necessity—if good and satisfactory results are to be achieved—of providing covered storeage room for the coal is therefore very generally admitted, and acted upon.

When coal in a wet or moist condition is placed in the retorts to undergo carbonization, the results are unsatisfactory in several

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respects. In the first place, the temperature of the retorts is reduced; and, as a consequence, extra fuel is consumed in restoring the temperature, and in drying the coal by evaporating the moisture, and driving it off as steam before the coal is in a fit condition to undergo destructive distillation.

If the mischief caused by the wet or moist coal ended here, it would be tolerable. But it does not. A portion of the moisture or steam is decomposed in contact with the sulphide of iron (Fe S) produced by decomposition from the bisulphide of iron or iron pyrites ($Fe S_2$) contained in the coal. The oxygen combines with the iron, forming the oxide of that metal; and the hydrogen with the sulphur, producing sulphuretted hydrogen. Bisulphide of carbon is also formed in considerable volume. In this way the whole of the sulphur present in the coal is caused to pass off into the gas, and has to be subsequently removed in the process of purification; thus increasing the cost of manufacture. On the other hand, when the coal is distilled in the dry state, rather more than one-half of the sulphur present is left behind in the coke.

These are the principal drawbacks attending the presence of water or moisture in connection with gas manufacture. In a future paper, I hope to point out the advantages which the gas manager derives from the use or presence of water under other conditions.

On the motion of Mr. DALGLIESH, seconded by Mr. W. W. HUTCHINSON, the discussion of the paper was postponed.

The PRESIDENT, before closing the proceedings, took the opportunity of expressing, in the name of the Institution, their pleasure at seeing present Mr. Henry Woodall, the President of The Gas Institute. They were, he said, always glad to see the heads of the profession at their meetings, and to learn from the experience they had gained in the past.

Mr. WOODALL, who was received with applause, thanked the members for their kind greeting, and said he really ought to apologize for being so late. He came too late to contribute anything in the way of discussion. It was his loss that he was not present to hear the discussions. He was glad, however, to be with them; and it was always the greatest possible pleasure to him to be where gas managers assembled.

The members afterwards took tea together.

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Walker, A. B.	Berwick.
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Helps, J. W. . . . . Croydon.
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Livesey, G. . . . . Tunbridge Wells.
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White, W.	Denmark Hill.
Wilkinson, T.	Newmarket.
Wilson, G.	Lewes.
Wilton, J.	Silvertown.
Winter, A. F.	Sevenoaks.
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ASSOCIATION OF GAS MANAGERS.

President.

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(President for 1889: J. H. Cornish, Bridgwater

Vice-President.

H. G. CROWE, Wellington.

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Committee.

J. H. GRAY, Weston-super-Mare.
A. V. DANIEL, Portishead.
S. W. DURKIN, Southampton.
W. HIGGS, Basingstoke.
W. FAULKNER, Romsey.
J. S. INESON, Ventnor.

New Members of Committee for 1888-9.

R. BEYNON, Torquay.
J. H. LYON, Cosham.

Auditor.

J. NICHOLLS, Crewkerne.

Members.

Anderson, T.	Bath.
Ashton, R.	Barnstaple.
Ball, C. E.	Ilfracombe.
Bark, S.	Godalming.
Barnfield, E. J.	Chepstow.
Bennett, W. C.	Tiverton.
Bennett, C. V.	Wells.
Beynon, R.	Torquay.
Brinkworth, W. H.	Chippenham.
Budd, W.	Melksham.
Cockey, H.	Frome.
Cornish, J. H.	Bridgwater.
Cowling, W.	Liskeard.
Crowe, H. G.	Wellington.
Daniel, A. V.	Portishead.
Davis, W.	Poole.
Durkin, S. W.	Southampton.
Edwards, A.	Taunton.

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Farrand, F. F.	Ryde, Isle of Wight.
Faulkner, J.	G. W. Ry., Swindon.
Faulkner, W.	Romsey.
Folkard, C. W.	Bournemouth.
Garnett, G.	Ryde, Isle of Wight.
Giles, T.	Bridport.
Gough, J. G.	Calne.
Gravett, H.	Bradford-on-Avon.
Gray, J. H.	Weston-super-Mare.
Greenaway, J.	Truro.
Griffin, J.	Fareham.
Grist, R. L.	Brimscombe.
Hardick, T.	Salisbury.
Hastings, C. W.	London.
Higgs, W.	Basingstoke.
Hopper, J. H.	Glastonbury.
Howell, E.	Yeovil.
Humphrys, N. H.	Salisbury.
Hunt, C.	Blandford.
Ineson, J. S.	Ventnor, I. of W.
James, J. D.	Exmouth.
Jervis, J. J.	New Swindon.
Kilminster, W. E.	Truro.
Livesay, J. G.	Ventnor, I. of W.
Livesey, D. L.	Aldershot.
Lowe, J.	Weymouth.
Lyon, J. H.	Cosham.
Mountford, W.	Andover.
Murphy, A. M.	Cirencester.
Newman, J.	Sandown, I. of W.
Nicholls, J.	Crewkerne.
Padfield, W. A.	Exeter.
Parlby, W.	Hereford.
Phelps, Joseph	Marlborough.
Portbury, W. H.	Teignmouth.
Rafarel, W. C.	Barnstaple.
Reed, J.	Newport, I. of W.
Riley, E. C.	G. W. Ry., Swindon.
Sainsbury, H.	Trowbridge.
Sapey, E. D.	Horsham.
Shepherd, H. C.	Old Swindon.
Stallard, G.	Havant.
Stone, T.	Weymouth.
Tall, J.	Dartmouth.
Taylor, F. C.	Shanklin.
Thomas, A.	West Cowes.
Thomas, J.	Bodmin.
Tinney, W. U.	Winchester.
Vincent, H. F.	Frome.
Vinson, W. E.	Gloucester.
Walker, G.	Westbury.
Walker, W. A.	Worthing.
White, T. W. R.	Sherborne.
Willey, H. F.	Exeter.
Williams, T.	Bideford.

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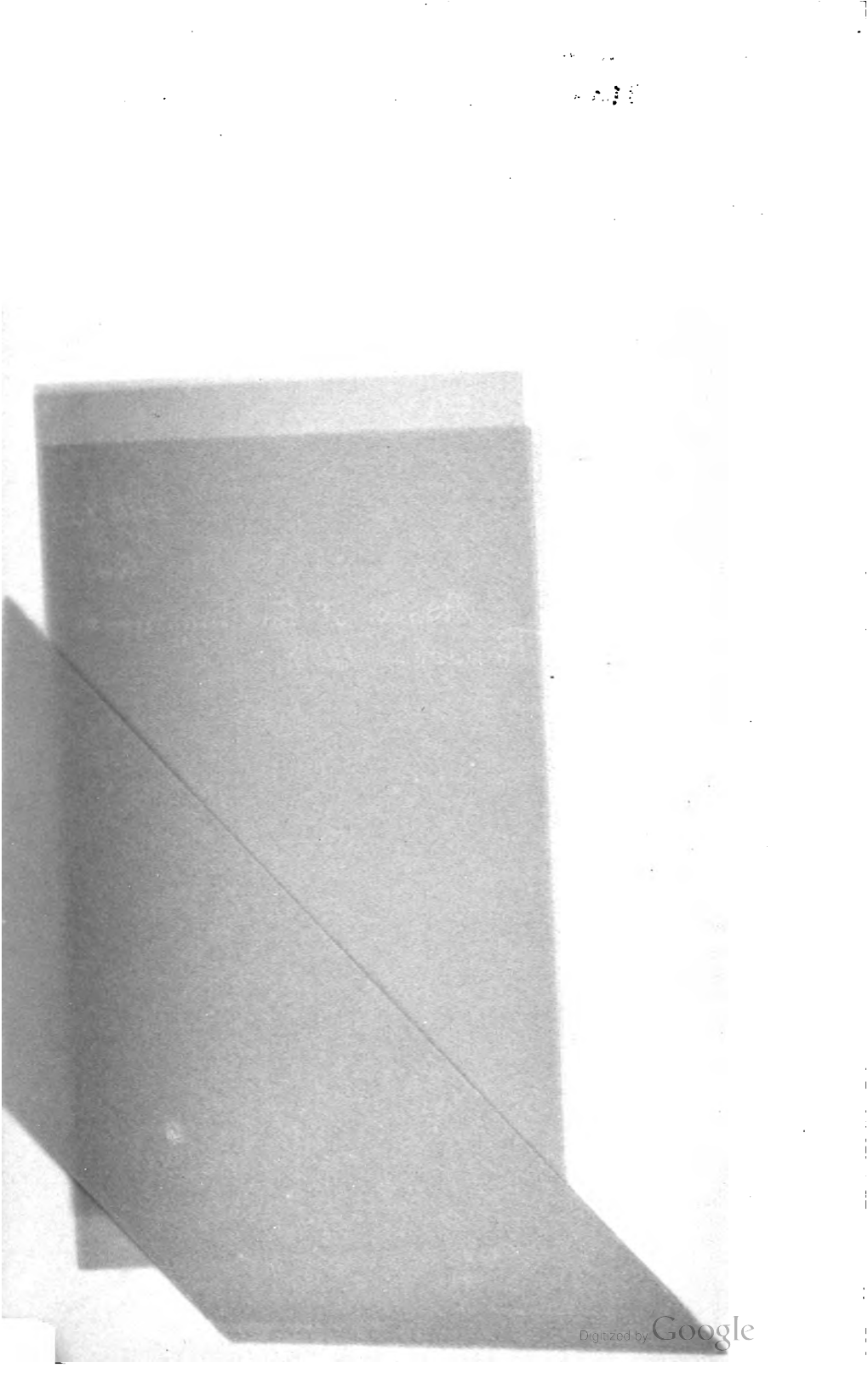
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